SUNDYNE
LMV-313 PUMPS

Instruction and Operation Manual

August 2007

Sundyne CORPORATION®

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Warranty

Sundyne Corporation warrants to Buyer for a period of twelve (12) months from the date of being placed in service (but not to exceed eighteen (18) months after the date of shipment) that the equipment at the time of shipment will be free from defects of design, material and workmanship. If any defects or malperformance occur during the warranty period, Sundyne's sole obligation shall be limited to alteration, repair or replacement at Sundyne's expense, F.O.B. Factory, of parts or equipment, which upon return to Sundyne and upon Sundyne's examination prove to be defective. Equipment and accessories not manufactured by Sundyne are warranted only to the extent of and by the original manufacturers' warranty. Sundyne shall not be liable for damage or wear to equipment caused by abnormal conditions, vibration, failure to properly prime or to operate equipment without flow or caused by corrosives, abrasives or foreign objects. THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, WHETHER EXPRESSED OR IMPLIED INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. In no event shall Sundyne be liable for consequential or incidental damages.

Contents

INTRODUCTION & SAFETY

Text Symbols

The following symbols may be found in the text of this manual.

They have the following meanings:

WARNING: Text accompanied by this symbol indicates that failure to follow directions could result in bodily harm or death.

ELECTRICAL HAZARD: Text accompanied by this symbol indicates that failure to follow directions could result in electrical damage to equipment or electrical shock.

RECOMMENDED: Text accompanied by this symbol indicates recommended usage.

REMINDER: Text accompanied by this symbol indicates a reminder to perform an action.

EQUIPMENT USE ALERT: Text accompanied by this symbol indicates that failure to follow directions could result in damage to equipment.

Equipment and Safety Precautions

Sundyne Corporation manufactures centrifugal pumps to exacting International Quality Management System Standards (ISO 9001) as certified and audited by Lloyd's Register Quality Assurance Limited. Genuine parts and accessories are specifically designed and tested for use with these products to ensure continued product quality and performance. Sundyne cannot test all parts and accessories sourced from other vendors; incorrect design and/or fabrication of such parts and accessories may adversely affect the performance and safety features of these products. Failure to properly select, install or use authorized Sundyne pump parts and accessories is considered misuse and damage or failure caused by misuse is not covered by Sundyne's warranty. Additionally, modification of Sundyne products or removal of original components may impair the safety of these products and their effective operation.

CAUTION

Sundyne pumps may handle hazardous, flammable, and/or toxic fluids. Proper personal protective equipment should be worn. Precautions must be taken to prevent physical injury. Pumpage must be handled and disposed of in accordance with applicable environmental regulations.

***Note**: Safety procedures must be applied prior to any installation, maintenance, or repair of a Sundyne pump. Failure to follow safety precautions may lead to injury!*

Wearing Personal Protective Equipment

To ensure safety, protective equipment must be worn at all times when installing, performing maintenance, or repairing equipment. The following safety recommendations must be adhered to for optimum safety:

- Safety glasses, with the minimum requirement of side shields, must be worn at all times.
- Steel-toed shoes must be worn when lifting equipment greater than 15 pounds (7 kg) or if pallet jacks or forklifts are operated.
- Hearing protection is strongly recommended at all times when noise levels exceed 85 dB during an eight (8.0) hour period.

***Note**: Chemical resistant gloves must be used if chemicals are utilized (refer to Using Chemicals for additional information).*

***Note**: A dust mask respirator must be worn if chemicals have warning labels regarding fumes, dust, or mists.*

When using more than one piece of protective equipment, consider their compatibility. For example, safety glasses will not interfere with hearing protection equipment. Be sure to clean all pieces of personal protective equipment immediately after each use.

Using Forklifts

Any persons operating a forklift must have an active recognized operator license.

***Note**: Before initializing forklift operation, verify that the lift is in a safe operating position.*

Ensuring Electrical Safety

All electrical sources must be powered-off before installation, service, or repair of equipment occurs.

***Note:** Sundyne recommends that a Lock-out/Tag-out program be followed prior to altering the equipment. Locks or tags must be provided to warn employees that equipment is temporarily unavailable.*

Once all work has been completed, the person installing the lock or tag must remove it according to company procedure.

Testing Equipment

Prior to performing a test on newly installed, maintained, or repaired equipment; all personnel in the immediate area must be warned.

***Note**: Follow company procedures prior to equipment testing at all times.*

Using Chemicals

Any chemicals to be used must be accompanied by a relevant material safety data sheet (MSDS), in accordance with government legislation. If applicable, use chemical proof gloves.

***Note**: An eye wash station (or equivalent) should be available in the event of injury. If any hazardous or flammable chemicals pass through the equipment, a complete decontamination of the equipment is required.*

Protection from Falling

Fall protection and associated preventative measures are required when working on equipment located six feet or higher from the ground.

***Note**: Follow company fall prevention procedures prior to working on equipment.*

Preventative Machine Guards

Preventative guards must remain in place on all equipment.

***Note**: Only remove the guards while performing maintenance or repair.*

Replace the guards immediately after working on the equipment and prior to start up.

EXPLOSION/FIRE HAZARD

***Note:** Never use an acetylene torch, open flame, or heat to attempt to remove parts that have seized together in Sundyne equipment. Any residual process gas or liquid that is flammable can result in an explosion or fire with potential for serious injury or death.*

TRANSPORT AND STORAGE

Inspection

Immediately inspect your Sundyne product upon receipt of the equipment. Check for any damage, which may have occurred during shipment. Notify the carrier and Sundyne immediately if damage is evident.

***Note**: The input shaft on the pump may not turn freely due to seal drag and speed increasing gear meshes. If the input shaft does turn freely, and if rotation is "not smooth," damage may have occurred during shipping.*

Storing Your Pump Short-Term

If your Sundyne pump is not to be installed immediately, protect it from exposure to moisture and dust. Do not remove the factory installed shipping covers for casing flanges and seal ports. Ensure that the shipping covers be kept securely in place.

***Note**: Observe the storage instructions provided by the driver manufacturer.*

Storing Your Pump Long-Term

In addition to the precautions in the short-term section above, additional precautions are required for long-term storage.

If your Sundyne pump will not be operated for a period of time exceeding six months from the date of shipment, long-term storage conditions must be met to ensure minimum corrosion damage to components.

***Note**: Sundyne does not accept liability for equipment damaged during the storage period. Sundyne does not guarantee the quality of equipment during and after the storage period.*

To ensure the original quality of the Sundyne pump after storage, all components must be inspected by an authorized Sundyne service engineer. Components that are not manufactured by Sundyne (except mechanical seals) must be inspected by its own manufacturer.

***Note**: Any inspection fees are the sole responsibility of the purchaser.*

Factors, which affect the quality of a Sundyne pump, when stored, are:

- Humidity
- Temperature
- Surrounding chemicals

Long-term storage methods must prevent damaging conditions from making contact with the internal components of the equipment. When the equipment is stored in strong chemical environments or near salt water, protection must occur immediately upon receipt of the equipment.

Recommended Long-Term Storage Procedures

Sundyne recommends that you do the following to prevent damage to your pump during long-term storage:

1. Store your pump only in an indoor, climate-controlled building. These conditions will maintain constant temperature and humidity.
2. Perform inert gas purging of component internals.

3. Ensure oil flooding of gearbox internals.
4. Use desiccant bags.

Note: *Because long-term storage of equipment is of a highly critical nature, it is recommended that Sundyne be contacted to provide more details on the above procedures.*

PRODUCT DESCRIPTION

Sundyne Centrifugal Pumps

Sundyne pumps provide high-energy performance and competitive efficiencies in an industrial quality, compact unit that is simple to maintain. Sundyne pumps are single stage that utilizes an integral gearbox. Designed to increase the pressure of a continuous flow of fluid by applying centrifugal action, Sundyne pumps are most commonly used in HPI, CPI, and Boiler Feed applications. Commonly applied in refineries, petrochemical plants, and power generation plants, Sundyne pumps are used in high-head, low-to-medium flow processes. This manual presents installation, servicing, troubleshooting, maintenance and spare parts information for the latest configuration of Sundyne centrifugal pumps.

Note*: Parenthetical numbers included in the text correspond to item numbers on the illustrated figures. The correct spare part can be ordered for any generation pump by referencing the item and serial numbers.*

INSTALLATION

Suction and Discharge Piping

Please adhere to the following best practices for installing and maintaining suction and discharge piping:

1. Install a suction (35-40 mesh) strainer and clean the suction line prior to starting the pump. This procedure will protect the impeller from damage by mill scale, welding slag, or other foreign particles during initial startup.

Note: *Sundyne Recommends installation of a differential pressure instrument across strainer to indicate strainer condition.*

2. When installing piping to the pump, ensure that all piping is supported independently from the pump.
3. All piping must always line up with the pump flanges.

Note: *Never use force to position piping into place at the flanged suction and discharge connection locations. Failure to have piping properly aligned may impose excessive strains on the unit.*

4. Sundyne recommends using a straight pipe assembly of at least three times the length of the pipe diameter.

Note: *Carefully select the size of pipe and fittings to be installed so that friction losses will remain low.*

5. Never use a suction pipe that is smaller in diameter than the pump suction inlet.
6. Sundyne recommends installation of a discharge check valve to prevent reverse rotation.
7. Use block valves (both suction and discharge) when isolating the pump during shutdown. This practice will minimize process leakage and prevent possible reverse rotation from pump back-flow.
8. It is recommended that suction and discharge pressure gauges be installed on any pump that is not flow controlled. If no flow measuring device is installed there is no way to determine accurately where on its curve the pump is operating.

Diffuser Cavity Vent

The diffuser cavity vent must be open to atmosphere or to a safety drain with no backpressure. See figure “Wet End Components” for location.

Note: Process fluid may accumulate causing a potentially hazardous situation if the diffuser cavity is not properly vented.

Seal Environmental Control System

A seal environmental control system may be required depending upon the pump seal arrangement and application.

Always maintain the pump seal environment as detailed on the specification sheet that accompanies each unit.

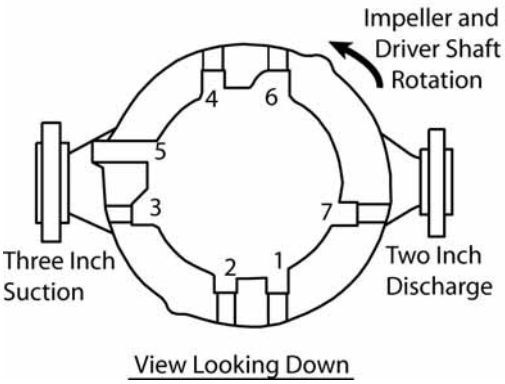
Note: *For most applications, a standard control system can be obtained from the factory.*

Note: *Diffuser Cavity Vent must be vented to atmospheric drain.*

Ensure that the specified seal environmental control system is properly installed and that the ports are open (or plugged) as indicated in Figure 1.

Note: *Port 1 must always be open or routed to flare so that it is free to drain.*

Figure 1. Seal Housing Port Identification



Port	Description
1	Seal Drain, Gearbox Oil **ALWAYS OPEN**
2	Seal Drain (Single Seal) or Buffer Fluid Out (Self Circulating) or Plug (Tandem Seal when Specified)
3	Cooling In (Normally Plugged)
4	Cooling Out (Normally Plugged)
5	Seal Flush (Start Up Venting)
6	Seal Flush
7	Seal Drain (Single Seal) or Buffer Fluid In (Self Circulating) or Plug (Tandem Seal when Specified)

Note: *Port 5 is the highest point in a vertically mounted pump and should be used for start up venting only.*

Liquid Buffer System

For double liquid seals and tandem liquid seals, A liquid buffer system is used. Introduce the buffer liquid into port 7, which will flow through the seal cavity, and out from port 2.

Buffer flow should be 0.5 to 3 gpm (2 to 12 liters/min) with an inlet temperature of 60° to 120°F (16° to 49°C), and inlet pressure as indicated on the pump specification sheet. The liquid must be clean to 5 microns.

Mounting Vertical Units Without Stands

For all vertical units without stands, a mounting base is recommended. The pump should be mounted on a rigid foundation, secured in position by one-inch diameter bolts. The bolts should be installed in the foundation as shown on the installation drawing. The length of the bolts should be sufficient to extend at least ½-inch above the nut.

Mounting Vertical Units with Stands (LMV)

Grouting of the base plate is required for all vertical stand units. The top of the stand (driver mounting surface) should be leveled by shimming under the base prior to grouting the channels that are to be filled with grout through the access holes. The nuts on the foundation bolts should not be tightened until the grout has set for at least 48 hours.

Base Mounted (BMP) Units

Grouting of the base plate is required on all BMP units. The base plate should be leveled prior to grouting. After grout has been applied, it must be allowed to set for at least 48 hours before tightening foundation bolts.

Driver and Coupling

Drivers are normally shipped separately from the gearbox and pump. When a splined interconnecting shaft is supplied, this shaft must be lubricated at each end with one tube (5cc) of anti-fretting compound (Sundyne Part Number MP01AA10).

Also available are solid shaft drivers coupled to the gearbox with a flexible coupling. Drivers are to be installed and maintained in accordance with the manufacturer's instructions.

Flexible Coupling for LMV Units Without a Vertical Stand

Note: *Lock out the driver starting switch before working on the coupling.*

When installing flexible couplings, use those supplied by Sundyne to ensure tolerance of parallel and angular misalignment, and axial end float. Use flexible disc couplings or gear type couplings if not using those supplied by Sundyne. Coupling installation for turbine drivers is identical to that for motors.

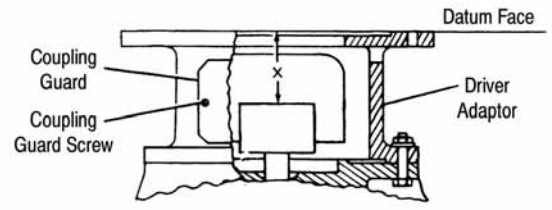
The gearbox coupling hub is normally mounted at the factory. The driver coupling hub is mounted on all motors and turbines shipped directly from Sundyne.

Driver Coupling is Not Mounted

If your product is received without the driver coupling hub mounted, use the following procedure when installing Falk or Thomas couplings:

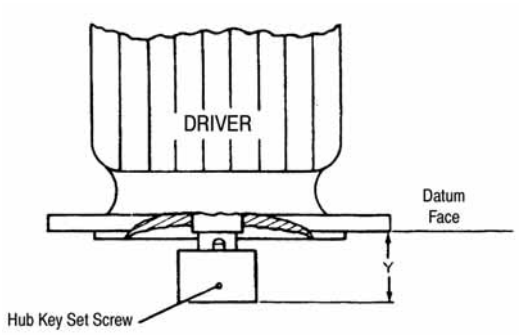
1. Measure the distance from the top surface of the gearbox hub, to the datum face of the driver adapter. This measurement is referred to as dimension "X".

Figure 2. Dimension X



2. Determine the end gap (the distance between each coupling hub) for the size of coupling provided. Refer to the Coupling Specifications tables in the Specifications section of this manual for specific measurements.
3. Subtract the end gap value from dimension X to determine the distance from the driver datum face to the coupling hub face This value is referred to as dimension "Y."

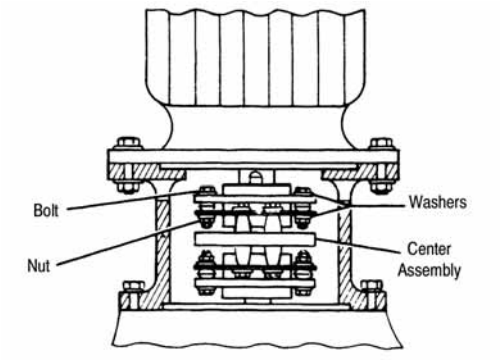
Figure 3. Dimension Y



4. Scribe the shaft to show dimension Y.
5. Ensure that the coupling hub bore, keyways, and shaft are clean and free from burrs. Also determine that the key fits in the keyways.
6. Heat the hub in an oil bath or oven to approximately 250°F (121°C), or more if necessary, so that the hub will slide onto the motor shaft.
7. Position the hub at the scribed line on the shaft.
8. Tighten the hub key set screw.

***Note**: Before the hub is installed onto the flexible disk couplings, verify that the coupling bolts and washers can be assembled (Figure 4) from the motor side of the hub when installed. If these pieces do not assemble, insert short bolts with bevel washers into the hub flange before fitting them onto the shaft.*

Figure 4. Assembly of Coupling Bolts and Washers



Lube System

The internal lube oil system engineered for Sundyne pumps consist of four major components. They are:

- Gearbox sump
- Main lube pump
- Oil heat exchanger
- Oil filter

The lube pump intakes oil from the sump and passes it internally to an externally mounted manifold. The oil is then passed through the heat exchanger, the filter, and back into the gearbox. Once the oil is passed through the bearings, it then drains back into the sump.

Gearbox Heat Exchanger

The standard heat exchanger is a shell and tube water-cooled type. For optimum performance, the following conditions must be met.

- Cool water must be provided to the tube side at a maximum pressure of 150 psig (11 kg/cm^2)(103.5Kpag).
- Coolant flow must be controlled to maintain a gearbox sump temperature between 140°F and 160°F (60°to 71°C).
- Maximum recommended temperature is 180°F (82°C).

The optional air-cooled heat exchanger should be controlled to maintain the same gearbox sump temperatures as above.

Mount the heat exchanger lower than the oil filter to prevent air pockets in the lube oil lines at start up. Air pockets can cause oil starvation at the bearings.

Note: *The heat exchanger installation is a Sundyne assembly and should not be rearranged. The heat exchanger is* ***NEVER*** *mounted higher than the filter.*

Oil Manifolds

There are two standard oil manifold configurations. MA01AA78 for units without heat exchangers and MA01AA79 for units with heat exchangers. For units purchased prior to 1991, the standard manifold is MA01AA01.

Figure 5. Heat Exchanger Manifolds MA01AA78 (left), MA01AA79 (Center), MA01AA01 (right).

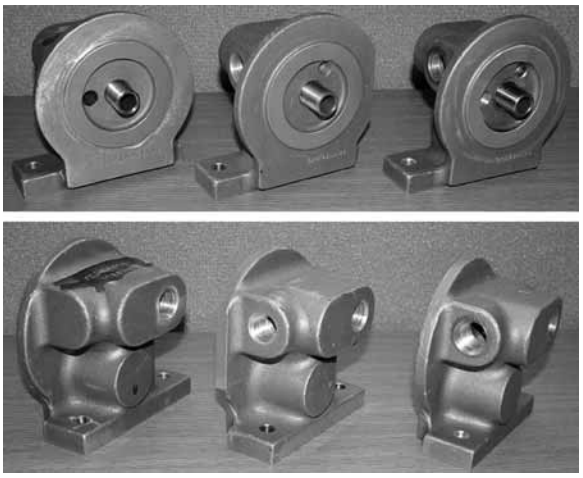
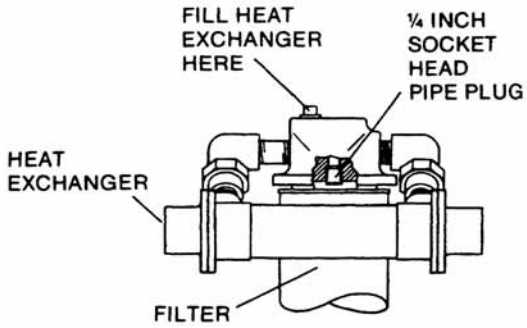


Figure 6. Heat Exchanger Mounting for MA01AA01 (units prior to 1991)



The MA01AA01 Model requires a 1/4" socket-head pipe plug in the filter manifold when using the gearbox heat exchanger. The plug must be removed when the heat exchanger is not being used.

Remote Heat Exchanger

All air-cooled heat exchangers as well as some large water-cooled heat exchangers must be mounted away from the gearbox.

Note: *Interconnecting piping is the purchaser's responsibility unless the piping is included with packaged units.*

All connecting piping, including fittings, must not exceed 20' (6m). The minimum requirement of all piping is 5/8" (16mm) inner diameter (I.D.) tubing or piping. If pipe lengths exceed 20' (6m), then the pipe diameter must be increased accordingly.

Gearbox Sump

The gearbox sump holds approximately seven U.S. quarts (6.6 liters) of oil, not including the oil contained within the auxiliary piping and heat exchanger. The oil level must always be maintained as recommended by Sundyne.

Note*: Sundyne recommends that the oil level must be within ¼" of top of the round sight glass when the machine is static (refer to the mark labeled "MAX").When the pump is in operation,the level will be approximately ¼" below the MAX level, with bubbles filling the rest of the glass.* ***Do not overfill the gearbox.***

Overfilling will cause overheating/ excessive foaming.

Gearbox Sump Heater (optional)

When gearbox oil temperature falls below –20°F (-29°C) it becomes too viscous for proper lube pump operation. A sump heater is required when these conditions may exist. Two types of sump heaters are recommended for these conditions - electric or steam.

SundGard® Oil Filter

The specially designed oil filter is rated for 3 microns at a beta ratio of 200.

***Note**: Oil filters other than Sundgard®-OEM filters will void the Sundyne warranty.*

The gearbox oil and filter should be changed every six months. Refer to the Lube Oil Specifications in the Specification section of this manual for more information.

Main Lube Pump and Lube Oil Priming Kit

***Note:** Use the auxiliary lube oil priming pump to circulate oil around the heater when the main drive motor is not running.*

The main lube pump is a positive displacement gear type pump directly driven by the input shaft.

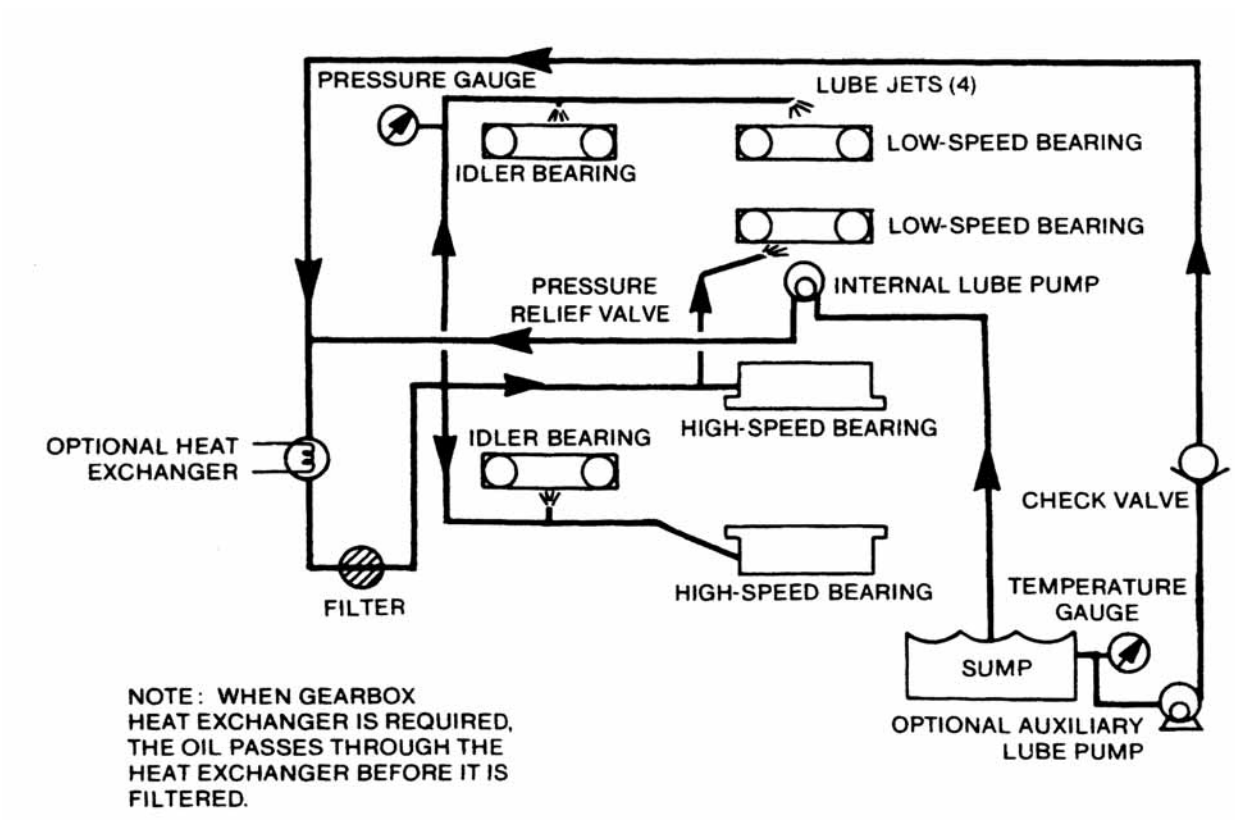
A pre-lube system is required on some pumps. The kit consists of:

- Motor driven positive displacement pump
- Check valve
- Gages
- Necessary piping

To start the pump, allow the pre-lube pump to run for approximately 30 seconds. There should be a minimum indication of 7 psig (0.5kg/cm^2) maintained for 30 seconds before starting the main driver. If the oil piping has been drained, allow several minutes of operation to bleed trapped air from the system.

***Note:** Only allow shut down of pre-lube pump after main driver is at full operating speed.*

Figure 7. Lube Oil Schematic



Oil Pressure

During normal operation the gearbox internal lube pump will maintain oil pressure between 15 and 60 psig (1.0 and 4.2kg/cm^2). This oil pressure can vary depending on the bearing configuration and characteristics of the oil being used.

***Note**: Never operate the gearbox with oil pressure less than 10 psig (0.7 kg/cm^2)*

COMMISSIONING, START UP, & OPERATION

Pre-Commissioning

Familiarizing Yourself with the Pump

Before servicing and starting up the Sundyne pump, carefully review all information on the product, including:

- Specification sheets
- Outline drawings
- Performance curves
- Instruction and related manuals
- System P&ID/Process Flow Diagram (Clients equipment)
- Control system and operational philosophy/narrative (Client)

Familiarize yourself with the pump configuration before starting and operating the pump.

Driver Instructions

Carefully follow all installation and starting instructions provided by the driver manufacturer. This information is included in the final data package.

Verifying Auxiliaries

Before start up, verify that the following auxiliaries are met:

- Check the utility connections
- Verify that the auxiliary piping conforms to Sundyne standards, as indicated in the detailed specifications
- Verify all switch and instrument connections
- Verify that all switch and instrument settings are set to normal operating standards
- Calibrate all measurement equipment, such as flow meters, ampere meters, and pressure meters, etc.

Installing a Seal Environmental Control System

Install a system to control the seal environment. Also, verify that port 1 is properly vented.

If required, install drain piping overhead to ensure that the environment operates under normal conditions. For more information, contact Sundyne Corporation.

Checking Driver Rotation

If the driver is coupled, un-couple; then verify that the direction of the driver rotates in the same direction as the arrow stamped or cast on the pump casing.

If the driver is splined, check the direction of the motor fan.

Piping Connections

Verify that the following bolted or threaded connections are tight:

- Pump flange bolts
- Seal environment piping and port connections
- Cooling water connections to heat exchanger (if applicable)
- Gearbox oil drain plug
- Pump case drain plug

Pre-Start Up

Pressurizing the Fluid Loop

Pressurize the double seal buffer loop or external seal flush, if applicable, prior to admitting fluid into the pump casing.

Servicing the Gearbox

Fill the gearbox with lube oil up to a quarter inch (¼) or 6 mm from the top of the oil level sight glass.

***Note**: Prior to using lube oil, verify that it conforms to acceptable lube oil specification standards. Refer to the SPECIFICATIONS section in this manual for more information.*

Under normal operation, the lube oil level will lower about a quarter inch more than when idle. Additionally bubbles will appear at the top of the sight glass.

***Note:** Sundyne recommends that gearbox lube oil be changed at least every six months.*

For requirement information about priming the lube oil system, refer to the start-up section in this manual.

Auxiliary Lube Pump

If your pump includes an auxiliary lubrication pump, unlock the electrical circuit and move it to the “hand” position. Check for oil leaks and recheck the oil level.

Setting the Valves

To set the pump to the designated operating point, start the pump with the suction valve in the open position while throttling the discharge valve.

Operating Conditions

Verifying Operating Conditions

Verify the following parameters against the specifications on the specification sheet:

- Suction pressure
- Suction temperature
- Discharge pressure
- Total head
- Flow rate
- Power consumption
- Specific gravity
- Viscosity
- Net Positive Suction Head (NPSH)

The status of these conditions will significantly alter performance of the pump if they are not in accordance with the specification sheet.

Check with your Sundyne representative if the operation conditions of your pump must run under different parameters than indicated by the specifications on the specification sheet.

Adjusting the Cooling Flow

If your model pump includes an installed heat exchanger for the gearbox, adjust the cooling flow to keep the temperature of the gearbox sump at 140°-160°F (60°-71°C). Maximum recommended temperature is 180ºF (82ºC).

Installation and Start-Up Checklist

***Note**: Lock out all switch gears, including main driver, auxiliary lubrication system and instrumentation before working on this equipment.*

This checklist is **NOT** intended to be inclusive. You must read and follow: instruction manuals, outline drawings, specification sheets and curves for this equipment during installation, commissioning, and operation. Your total satisfaction is our goal. Please call with any questions or comments. Be sure to have the unit serial number that is imprinted on the gearbox nameplate, and request "Sundyne Field Service".

- ❑ Is all the information underlined above readily available?
- ❑ Are the following bolted/threaded connections tight?
  - Pump flange bolts?
  - Seal environment piping and port connections?
  - Cooling water connections to heat exchanger(s)(if applicable)?
  - Gearbox oil drain plug?
  - Pump case drain plug?
- ❑ There are two types of connections between the motor and gearbox; a splined shaft or a coupling. For splined connections, the splined shaft must be lubricated with the supplied spline grease and the two o-rings installed prior to mounting the motor. It is recommended that the input shaft be rotated by hand prior to mounting the motor. If the unit has a coupling, be sure the coupling gap is correct and bolting between coupling halves is tight. This instruction manual contains coupling set-up information. It is not necessary to align the coupling for run-out or flatness as this is controlled by the rabbet fits on the gearbox and coupling adaptor.
- ❑ Is a check valve installed in the discharge line?
- ❑ Is port 1 open to atmosphere or piped to safety drain or flare or vent header? (Back pressure must not exceed 5 psig). Sundyne recommends the installation of a check valve in the flare piping to prevent backflow.

***Note**: A drip leg must be used if the port 1 connection rises from the seal housing.*

- ❑ Is the diffuser cavity vent open? (Plug must be removed.)

***Note:** Process fluid may accumulate causing a potentially hazardous situation if diffuser cavity is not properly vented.*

- ❑ Are all other seal system ports identified and connected according to the outline drawings?
- ❑ Is gearbox filled to within ¼" (6.35mm) of the top of the sight glass with the approved oil and the breather fitting installed? Oil capacity is 7 quarts (6.6 liters). Is the needle valve on the gearbox pressure gauge open? Removal of the vent plug below the fill/vent fitting will speed filling.
- ❑ Has the oil filter, heat exchanger, and related piping been filled with oil (primed)?
- ❑ Do process conditions, suction pressure, suction temperature, discharge header pressure, and specific gravity agree with specification sheet information? **DO NOT** test the pump on water unless it is designed for water. Check with your representative or Sundyne Corporation if you must test on a different fluid than shown on the specification sheet.
- ❑ If you have auxiliary lubrication pump, unlock the electrical circuit and start it in the "hand" position. Check for oil leaks and recheck the oil level. If the process suction pressure exceeds 460 psig (32.3 kg/cm2g), the auxiliary lube pump should be running prior to and anytime the suction is pressurized.

- Prior to starting the unit, have you opened the suction valve fully and discharge throttled to allow design flow, typically 40-50% open? Check the control valve to be sure it is functional. Inspect the case drain, ports, and flanges for leaks. Has the pump been vented through port 6? Open both supply and return valves supplying cooling water to the gearbox heat exchanger. Check suction pressure to be sure it agrees with the specification sheet.
- Unlock the main driver circuit and bump the motor. Rotation is CCW as viewed from the top end of the motor. Is rotation correct? Once rotation is verified, run motor for 1 second on, 20 seconds off. Do this several times until gearbox oil pressure gauge shows pressure, then start the main driver. Oil pressure will be between 15-60 psig (1.1-4.2 kg/cm2g) depending on the type of bearings in the gearbox. After commissioning, bumping the motor is not required.
- If pressure control is being used, throttle the discharge valve immediately after start-up. Does the discharge pressure agree with the specification sheet? If flow control is being used, adjust the valve until flow agrees with the design value listed on the specification sheet.
- Once the gearbox oil temperature has stabilized, adjust cooling water supply until the oil temperature is 140-160°F (60-71°C) on units equipped with heat exchangers. Maximum recommended temperature is 180°F (82°C).
- Listen for any unusual noises or pressure fluctuations.

Note: *If you have any questions or concerns about these procedures or the information supplied, please call your representative or Sundyne Corporation.*

Start-Up Procedures

Perform the following tasks to start the Sundyne pump.

1. Run-in of pump: If the pump is to be run under conditions which are considerably different from those conditions listed on the spec sheet (such as a change in specific gravity, suction pressure, flow rate, etc.) the factory should be consulted to ensure that the run-in conditions are compatible with the pump.
2. Check to ensure that the driver has been serviced per instructions provided by the driver manufacturer.
3. Auxiliaries - Check utility connections; verify that auxiliary piping is per Sundyne drawings; verify switch and instrument connections and set points; calibrate flow instruments and other transmitters.
4. Flushing screens should be installed in all field assembled piping connections.
5. Check the pump specification sheet and outline drawings for seal environment requirements. Be sure seal housing port piping is properly connected. If double seals are used, buffer fluid must be pressurized before suction pressure is applied to the pump. Port 1 must be open. Maximum allowable back pressure on Port 1 is 5 psig (0.35 kg/cm²). Refer to figure 1.

6. Check to ensure the diffuser cavity vent is vented.
7. Fill the gearbox with oil.

   Remove the gearbox fill-vent plug and the filter-breather cap from the fill opening on the gearbox. Fill gearbox within ¼ inch (6.4 mm) from top of oil level sight glass with lube oil, which conforms to the specification in Table 6. Where applicable, operate auxiliary lube pump to fill heat exchanger and filter. Add oil as necessary through fill fitting until oil level stabilizes in sight glass. The gearbox alone requires approximately 7 quarts (6.6 liters). Replace the filter breather cap on the fill-opening fitting and replace the fill-vent plug. If an auxiliary lube pump is not used, remove the plug on top of the oil filter (item 924g) manifold and fill the oil filter and the heat exchanger with oil (Figure 6).
8. Prime the lube oil system

   The following actions must occur at the time of initial pump installation and following every re-installation after maintenance that required the draining/removal of the gearbox lubricating fluid.

   Verify that gearbox lube oil pressure will be achieved by priming the lube oil system and expelling all of the air that is potentially

trapped. Priming can be achieved by either operating the (optional) auxiliary lube oil priming pump or by jogging the main driver connected to the gearbox (oil pressure should be observed by the second or third jog - each of 2-3 seconds duration).

Note: *Jogging is required for initial installation or following re-installation after maintenance and re-filling of gearbox lubricant. Units remaining idle should be jogged once a month to prevent the bearings from brinelling and to prevent internal rusting.*

Jogging is also used to verify proper direction of rotation for the main driver. Jogging is a prudent, conservative activity that can be quite useful to ensure long service life of the Sundyne high-speed products by providing a fluid film of lubricant on the surfaces of bearings and gears.

After priming the lube oil system, check the oil level in the gearbox sump, and add oil as necessary.

Note: *Never start the pump against a closed discharge valve. Always check to ensure that the discharge valve is partially open*

After priming the lube oil system as defined above, the pump can now be routinely started without the need of jogging. This would include switching of main/stand-by units, start-up of idle reserve units, start-up of emergency units, etc. Non-operating units should be started/used every 9-12 months on an alternating basis.

9. If an auxiliary lube system is installed, it should be used in the following manner.
   a) At the initial startup or after changing the lube oil, run the pump for several minutes to work any trapped air out of the piping. Adjust the relief valve on the auxiliary pump to provide 25 psi (1.76 kg/cm^2) oil pressure to the system.
   b) The auxiliary system is intended to provide oil before starting the main driver. It should run for a minimum of 5 seconds at minimum pressure before the main driver is started. Pressure switches and time delays can be used if automatic start sequences are desired.
   c) After the start of the main driver, oil pressure will be supplied by the main lube pump inside the gearbox. An increase in oil pressure should be observed. Shut down the auxiliary pump within two minutes of the main driver start.
10. Adjust the heat exchanger cooling flow to regulate the gearbox sump temperature between 140° and 160°F (60° and 71°C). Approximately one hour may be required to stabilize the temperature.

    Maximum recommended temperature is 180ºF (82ºC).

Controlling the Pump During Startup

To ensure control of the pump during start up, follow the start up procedures for your desired configuration.

Single Operation

Start the pump with the suction valve open while throttling the discharge valve. This will ensure that the pump will reach the design flow operating point.

If the process fluid is near its vapor pressure, open the supply vessel seal cavity vent so that the pump can fill with liquid.

Parallel Operation

To prevent back-flow, place check valves in the discharge piping of each pump.

Note*: Sundyne recommends installing separate bypass loops around each pump for additional operational flexibility.*

1. Start the first unit as described in the Single Operation instructions.
2. Start the second unit with the bypass valve set to maintain the flow above minimum flow.

3. Open the discharge valve on the second unit so that the design flow of both units is maintained.

Note: *Do not operate the pumps at their peak head capability.*

Sundyne recommends that separate flow controls be used on each pump to provide a lower minimum flow range than is achieved by pressure control.

Operation of Sundyne Pumps

Under normal operation, several factors must be taken into consideration to ensure successful pump operation. Experienced pump operators will be aware of jeopardizing factors and their effects.

Suction Conditions

Improper flow of liquid into the impeller is the most common operational abuse of centrifugal pumps. Two conditions must exist to prevent turbulence at the eye of the impeller.

- Proper suction piping, see suction piping section.
- Liquid reaching the impeller eye must have enough vapor pressure to prevent the fluid from flashing to a gas in the impeller. If this condition occurs, it will cause cavitation, which can damage the impeller and inducer. When centrifugal pumps cavitate the noise sounds like the pump is “pumping gravel”. In high speed, single stage pumps, this sound may not be discernable. Cavitation can be prevented by maintaining suction pressure at a high enough level and suction temperatures low enough to maintain Net Positive Suction Head (NPSH) available greater than Net Positive Suction Head ($NPSH_r$) required by the pumps.

Minimum Flow Conditions

Vibration and noise will occur during operation of centrifugal pumps if either of two conditions exist:

- Internal flow separations
- Recirculation at low flow conditions

If the operator is noticing excessive noise or vibration, operation must be suspended until the cause is determined and corrected. Continued use may cause damage to the pump. Resonance in the discharge line can accentuate noise, vibration, and damage to the pump, primarily when a control valve is located an excessive distance downstream from the pump.

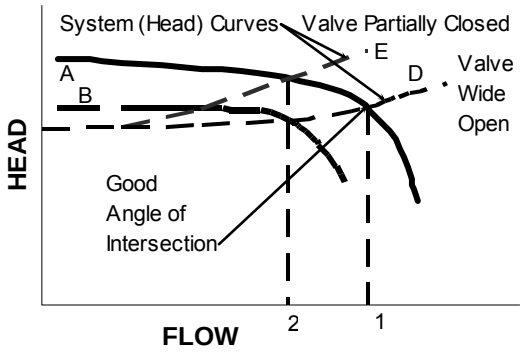
Entrained Gases

The head and capacity of centrifugal pumps will be reduced by gas that is drawn in with the liquid. Under normal operating conditions, centrifugal pumps can tolerate up to 2% of gas (by volume). Entrained gases can cause damage to mechanical seals with the exception of double seals. If you have entrained gas, contact Sundyne for further instruction.

System Head Curve

The point of intersection between the system curve and the pump characteristic curve determines the flow or operation for the centrifugal pump. For steady flow to occur, the system curve must intersect the pump characteristic curve at a significant angle. The following diagram gives examples of satisfactory and unsatisfactory angles of intersection.

Figure 8. Typical Operation



Note: *The curve for pump A has a significant angle of intersection with system curves D and E. The system curve D could represent a system with the control valve wide open while curve E could represent the same system but with the throttle valve closed to reduce flow from flow 1 to flow 2. Pump curve B, on the other hand, will provide only flow 2, even with the control valve wide open*

(curve D). When the control valve is partially closed to create system curve E, the curve E and lower pump curve B are practically parallel. The lack of a significant angle of intersection means that the system is unstable, pump flow is likely to fluctuate eratically and not respond to control valve position.

Parallel Operation

Maximizing control is critical when operating centrifugal pumps in parallel. One pump can overpower the other in regards to head at a lower total flow. If a simple, unrestricted manifold connects two pumps at the discharge head, the discharge head of one pump is imposed on the other. All pumps will see the same discharge head at a given time. This is demonstrated on the following diagrams.

The characteristic curves of two pumps designated A and B are demonstrated in the Parallel Operation figure.

Since no two pumps will have exactly the same performance, it is assumed that pump A produces a slight amount more head than pump B. The pumps are arranged with a common manifold as shown in Parallel Units Common Valve figure.

Figure 9. Parallel Operation

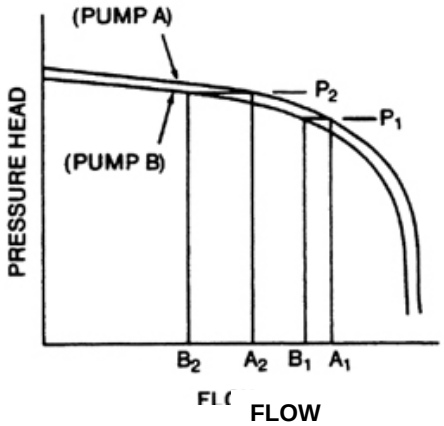
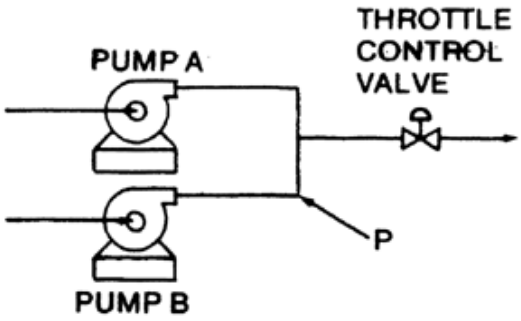


Figure 10. Parallel Units Common Valve



The pressure in the manifold is set at P_1; the flow through pump A indicated as A_1 on the preceding curve. At the same time, the flow through pump B is indicated as B_1. However, if the throttle valve is closed to cause the manifold pressure P to rise to P_2, then flows through pump A and B are A_2 and B_2 respectively. If the throttle valve were closed even further, then pump B would cease to flow entirely. Since pump B would effectively be deadheaded, the fluid in it would heat up and boil. During internal boiling, it could encounter liquid slugging and probable damage to the pump. Proper selection of a control system can prevent this situation.

MAINTENANCE

Disassembly of LMV-313

STEP 1

Remove the nuts from the pump casing studs. Lift the gearbox and seal housing up off of the pump casing. Remove o-rings 936B and 936CB and backing ring 70B.

When lifting, if the pump case and seal housing are difficult to separate, use the three jacking screws to break the seal.

STEP 2

Install the anti-rotation device to prevent impeller from spinning.

Note: Locking tools, part number TO01AK03 for splined or TO01AK02 for coupled shafts, are available for purchase from Sundyne Corporation.

STEP 3

Remove the inducer.

Note: All inducers have a left-handed thread.

***Note**: When working on a pump with a tapered inducer, the inducer must be removed before the diffuser can be removed from the seal housing.*

STEP 4

Remove the inducer housing, shim, and o-rings 936CA and 936C.

Note: When a tapered inducer is used, the diffuser is bolted to the seal housing. When a straight inducer is used, the diffuser will remain in the pump case.

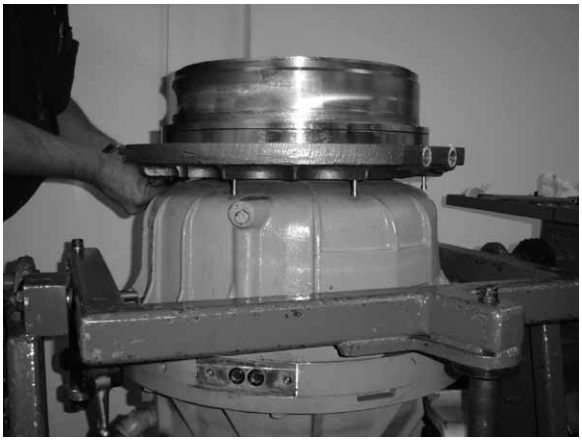
Removing the bolts from the inducer housing.

STEP 5

Remove the inducer stud and o-ring 936F.

STEP 6

Remove the six diffuser mounting bolts.



Build stand shown, part number T-MT-215, is available for purchase from Sundyne Corporation.

STEP 7

Install 3/8” eyebolts into the diffuser for lifting.

STEP 8

Carefully lift the diffuser off the gearbox housing.

STEP 9

Remove o-ring 936A from the diffuser cover.

Note: *These instructions reflect a tandem seal arrangement. If you have a single or double seal arrangement, refer to the seal arrangement drawings later in this manual for differences.*

STEP 10

Remove the impeller and o-ring 936G.

The impeller can be removed using two screwdrivers to pry up gently on opposite sides.

STEP 11

Remove the diffuser cover and o-ring 936E.

STEP 12

Remove the impeller spacer and o-ring 936G.

STEP 13

Remove the lower seal rotating face and o-ring 936J.

STEP 14

Remove the lower seal retaining bolts and remove the lower process seal.

STEP 15

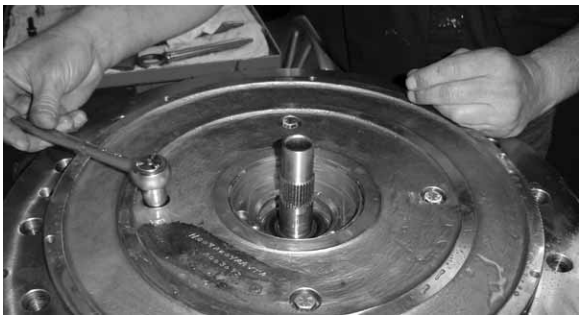
Remove the lower sleeve and o-ring 936J.

STEP 16

Remove the upper rotating face and o-ring 936J.

STEP 17

Remove seal housing bolts.



STEP 18

Insert eyebolts into the seal housing for lifting.

STEP 19

Lift off seal housing. Be careful not to damage the upper process seal on the high-speed shaft. Remove two 936H o-rings.

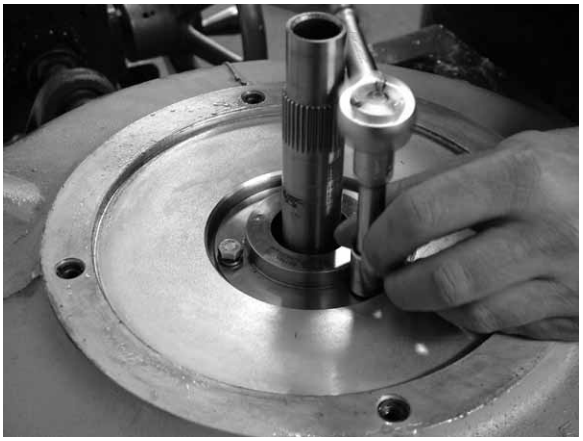
Remove upper seal.

STEP 20

Remove upper sleeve and o-ring 936K.

STEP 21

Remove the gearbox seal retaining bolts.



STEP 22

Remove the gearbox seal and o-ring 936P.

STEP 23

Remove the thermal barrier gasket.

STEP 24

Remove the gearbox seal rotating face.

Use extraction tools to remove the rotating face.

STEP 25

If no maintenance rack is available, loosen the nuts rather than the bolts.

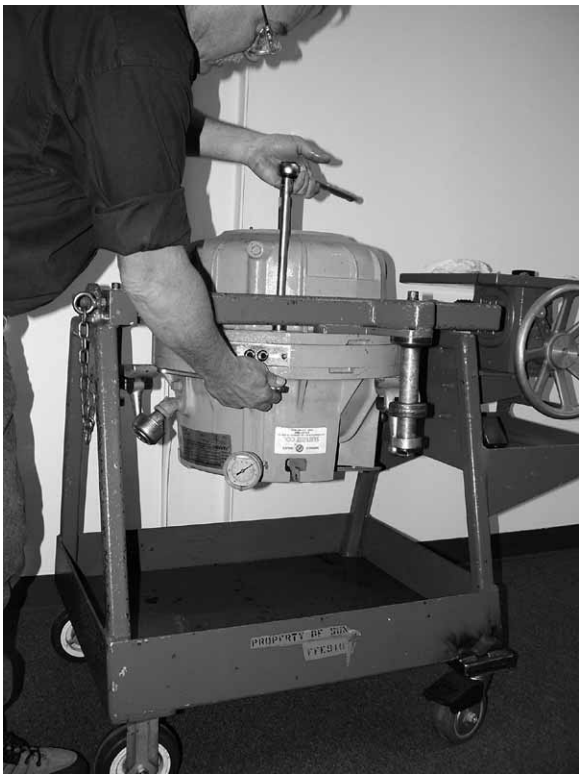
STEP 26

Remove the alignment bolts.

Note: Alignment bolts are close tolerance and must be removed first or damage may occur to the aluminum housing. Damage to the alignment bores can cause increased vibration and reduce gearbox life.

STEP 27

Remove the ½" gearbox housing bolts.



STEP 28

Remove the anti-rotation device.

STEP 29

Remove fill and vent cap from gearbox.

STEP 30

Remove the fill and vent fitting.

Use a pipe wrench to remove the fitting.

STEP 31

Lift off the upper housing.

Note: If necessary, a screwdriver (use cloth to protect the aluminum) can be used in the slots to assist in breaking the seal between housings.

STEP 32

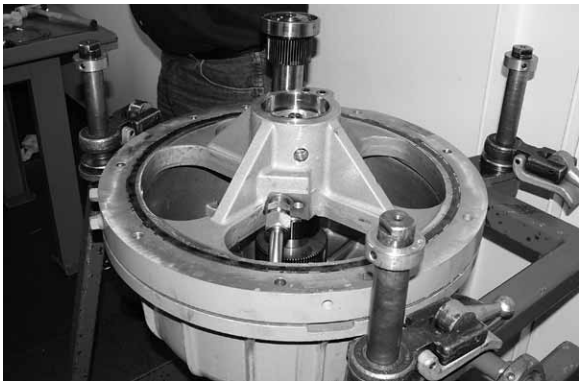
Tip the idler shaft out of the way by lifting it up and out of the lower bearing race and tilt it towards the outside of the gearbox.

STEP 33

Remove the input shaft.

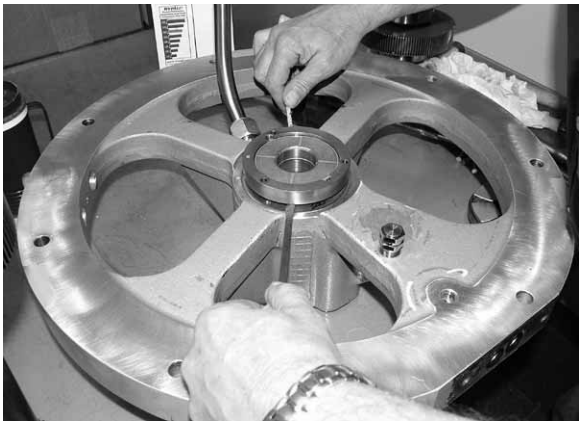
STEP 34

Remove the bearing plate. Turn over for high speed bearing removal.



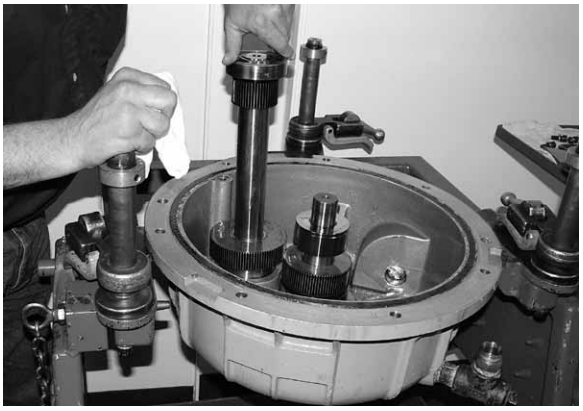
STEP 35

Remove the upper journal bearing and thrust washer, if supplied, from the bearing plate.



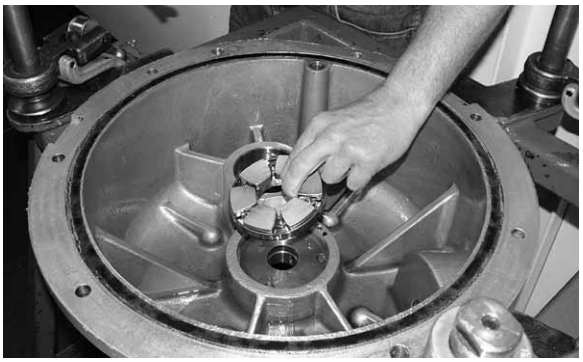
STEP 36

Remove the idler shaft and high-speed shaft assembly by lifting straight up.



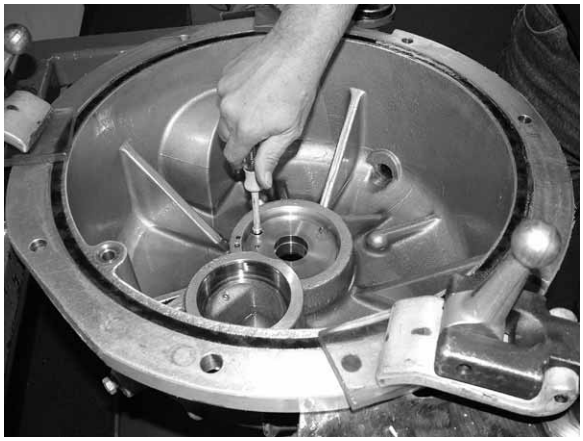
STEP 37

Remove the tilt pad bearing.



STEP 38

Remove the lower journal bearing.

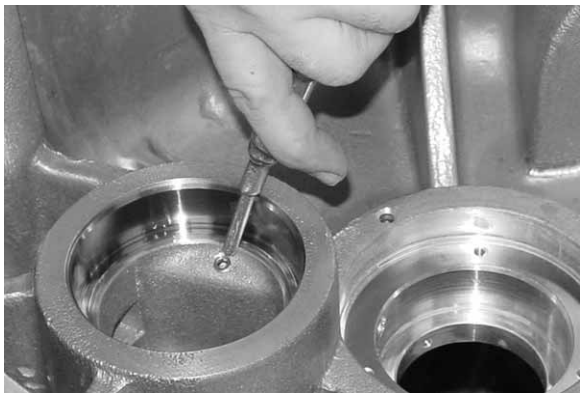


STEP 39

Remove the lube pump from the bearing plate. The longer two of the four bolts are used to hold the pump in the bearing plate and the shorter bolts hold the lube pump together.

STEP 40

Remove all lube jets and plugs, flush with solvent, then blow out all the lube passages.



Inspection and Cleaning and Repair

Inspecting All Bearings

Replace bearings if:

- They have been in operation for over three years
- If rotation is not smooth
- If outside of inside diameters are worn

***Note**: Only replace bearings with manufacturer's approved replacement bearings. Non-approved bearings may jeopardize the mechanical integrity of the gearbox and pump.*

***Note**: Refer to the Specifications section of the manual for all bearing and shaft clearances.*

High Speed Shaft

Inspect the High Speed Shaft at the thrust washer and journal bearing contact areas. Replace the shaft and gear assembly if:

- Outside diameter of shaft is less than 1.4960 inches
- If the shaft has bearing or washer materials on it's surface
- Shows signs of overheating
- Shows wear to a depth greater than 0.001" (0.03mm)

Inspect upper and lower thrust washers or tilting pad bearing assembly. If metal is smeared into radial lube grooves of the washer face, install a new washer. If the tilting pads do not fit freely, or if they show signs of metal pick-up or overheating, install a new bearing assembly.

***Note**: The radial "free play" of the high speed shaft can be as high as 0.011 inch (0.28mm) due to the clearance in the bearings. It is not possible to check for shaft straightness while the gearbox is assembled. To check straightness, the shaft must be placed in V-blocks, on it's bearing journals, and have runout measured at the impeller fit (0.0018 inch TIR max).*

Gearbox Mechanical Seal

Carefully inspect the seals for abrasive particles, excessive seal face wear and any binding of the seal face washer.

Replace or rebuild a faulty mechanical seal. Seals may be rebuilt by replacing the seal face washer, wedge rings, o-ring, and springs. A seal repair kit is available.

Replace or lap the seal rotating face if the wear track is rough or worn to a depth greater than 2 helium light bands.

A combined total of 0.010 inch (0.25mm) maximum may be removed from the surfaces of the pump and gearbox seal rotating faces. Excess material removal will result in incorrect seal face loading causing increased seal leakage.

Remove any high spots on the end surfaces of the lower shaft sleeve and impeller hub to insure that the seal rotating face will not be distorted by clamping force of the impeller bolt.

Reassemble the seal, throttle bushing, if used seal housing, and impeller using an o-ring repair kit. All o-rings that were disturbed by disassembly should be replaced. During reassembly, carefully check the torque values listed in Table 7.

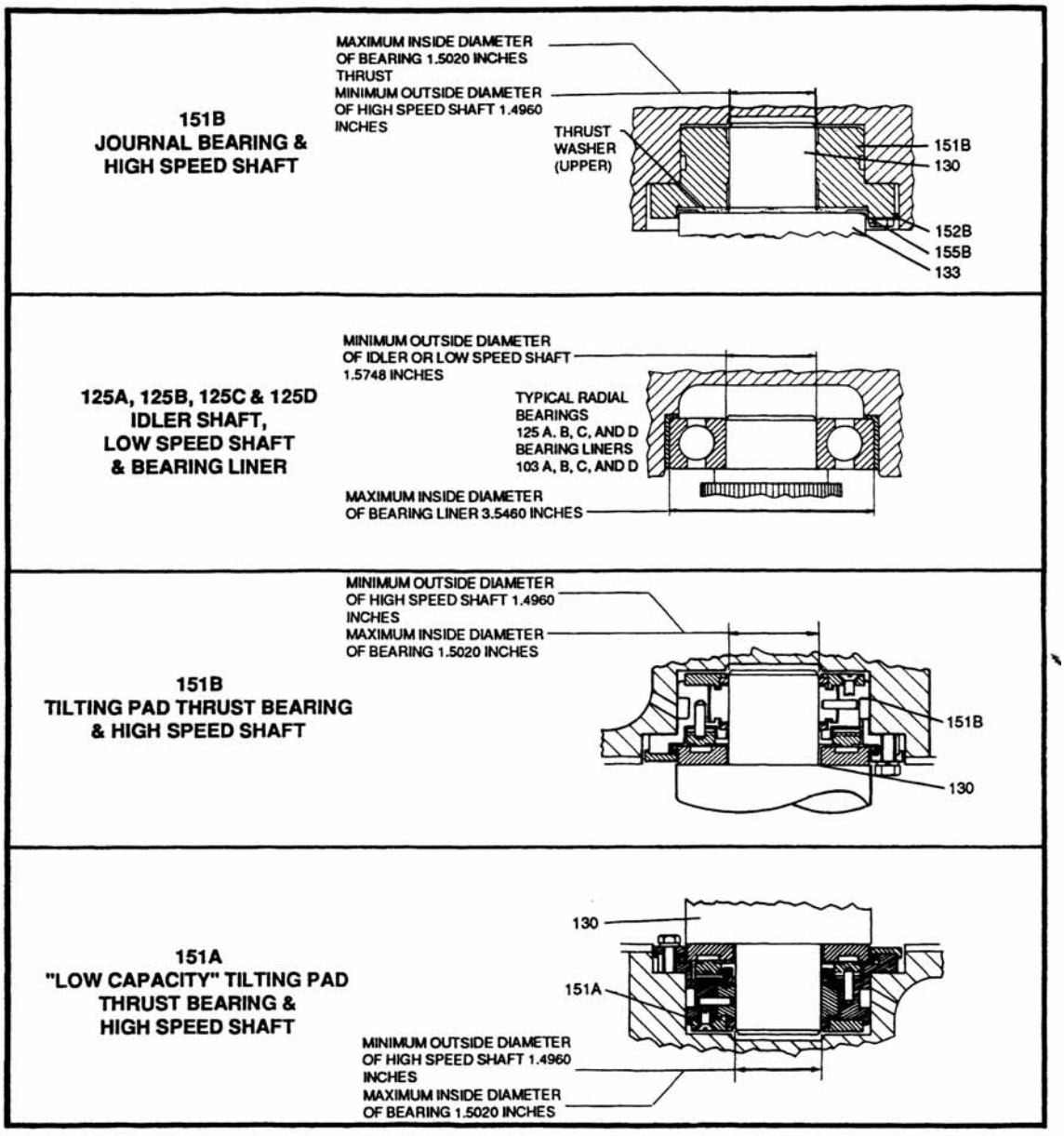
The impeller may rub on the diffuser cover plate (15) until o-rings (936D and 936E) are compressed by tightening hex nuts (914A). Check the gearbox input shaft for freedom of rotation after the pump is assembled and all bolts are tightened per Table 7.

Upper Shaft Sleeve

Ensure that there are no high spots on the end surfaces of the shaft sleeve or the impeller hub. High spots will distort the seal rotating face due to the clamping force of the impeller bolt. Ensure that shaft sleeve end faces are parallel within 0.0003” (0.0076mm).

Bearing and Shaft Clearances

Figure 11. Bearing and Shaft Clearances



Pump Assembly and Clearance Adjustments

General Clearance Adjustment Information

If disassembly of the wet-end is only for minor maintenance such as a seal change, the original shims should still be satisfactory. If any of the major components listed below have been replaced, changes to the original shimming will be necessary.

- Gearbox
- Seal housing
- Diffuser
- Pump case

Impeller Spacer Adjustments

Before proceeding, the gearbox should be fully assembled. The seal housing (30) and the thermal barrier gasket (87A) must be installed also. The diffuser cover (15) and process mechanical seals as well as all associated o-rings can be temporarily left off during this procedure.

Position the exit flow path from the impeller within the opening of the diffuser annulus by changing the thickness of the impeller spacer (158C). Make this adjustment with the thrust of the output shaft away from the gearbox.

Position the gearbox vertically with the output shaft up. Install the following components of the rotating assembly as well as the original impeller spacer (158C).

- Shaft sleeves
- Rotating faces
- Impeller

There are two methods for setting the impeller to the diffuser. Both methods require the use of a shaft loading tool. See Shaft Loading Tool Installation figure for how to install the shaft loading tool.

Method 1

Use a dial indicator and surface gauge to measure dimensions “A” and “B” from the Impeller Shim Adjustment figure. Record the readings. Use a depth micrometer to measure dimensions “C” and “D”. Compare “B” to “C” and “A” to “D”. Select the spacer thickness that will place the parts within tolerances for the position specified in the Impeller Shim Adjustment figure.

***Note**: Some diffuser openings are much wider than the impeller openings. The primary tolerance is the 0.025 ± .020 inch (0.635 ± 0.508 mm) setting. The diffuser opening must not overlap the impeller opening.*

Method 2

If the proper tools for measuring dimensions of “A” and “B” are not available, use this method. Measure the dimensions for “C” and “D” and transfer these dimensions to a template. Do this by scribing position marks to indicate the diffuser opening. Place the straight edge of the template on the seal housing and visually adjust the impeller opening to the scribe marks. To do this it is necessary to leave the diffuser cover (15) off. Otherwise it is necessary to put a notch in the template. An example of a transfer template can be seen in the Shaft Loading Tool Installation figure.

After completing either of the two methods, remove the shaft loading tool. Assemble the following parts:

- Process mechanical seals
- O-rings
- Shaft sleeves
- Seal rotating faces
- Diffuser cover
- Impeller spacer
- Impeller

Inducer Housing Shim Adjustments

Reinstall the bolt from the shaft loading tool and torque the impeller.

Remove the inducer housing (6) and shims (158F) from the diffuser (13).

Place the diffuser (13) over the impeller allowing it to rest on the seal housing surface. Make sure that both surfaces are clean. If using a tapered inducer, install o-ring (936A) and the diffuser screws (906F). When using a straight inducer, leave out o-ring (936A) temporarily.

Insert the inducer housing (6) into the diffuser bore without the o-ring (936CA) and shims (158F) installed. Install the crossover bar from the shaft loading tool and torque the nut for the proper preload. Allow firm contact between the end of the inducer housing and the impeller. The result should be a gap between the inducer housing and the diffuser where the shims are normally installed.

Measure the gap between the inducer housing flange and the diffuser using feeler gauges. Take readings from three points around the flange. Average those three readings. Record the average reading and add 0.010 inch (0.254 mm) to the gap reading. The result should indicate the shim thickness to produce the proper clearance. Confirm this number by comparing it against the number in the Inducer Housing Shim Adjustments figure.

The shim (158F) is made with 0.002 or 0.003-inch (0.051 or 0.076 mm) thick laminations. Peel off any layers that are not needed. Remove the inducer housing (6) and install the shim (158F), o-ring (936CA), and inducer housing (6) in the diffuser.

***Note**: Proper shimming of the inducer housing is critical. If not enough clearance is allowed the result will be impeller rubbing and hardware damage. If too much clearance is allowed a loss of performance will occur. A larger clearance is preferred to hardware damage.*

Remove the shaft loading tool. If using a tapered inducer, install and torque the inducer. For proper torque values see the Torque Values table. If using a straight inducer, remove the diffuser assembly and install it in the pump case. Install the inducer and continue with the pump assembly.

Figure 12. Impeller Shim Adjustment

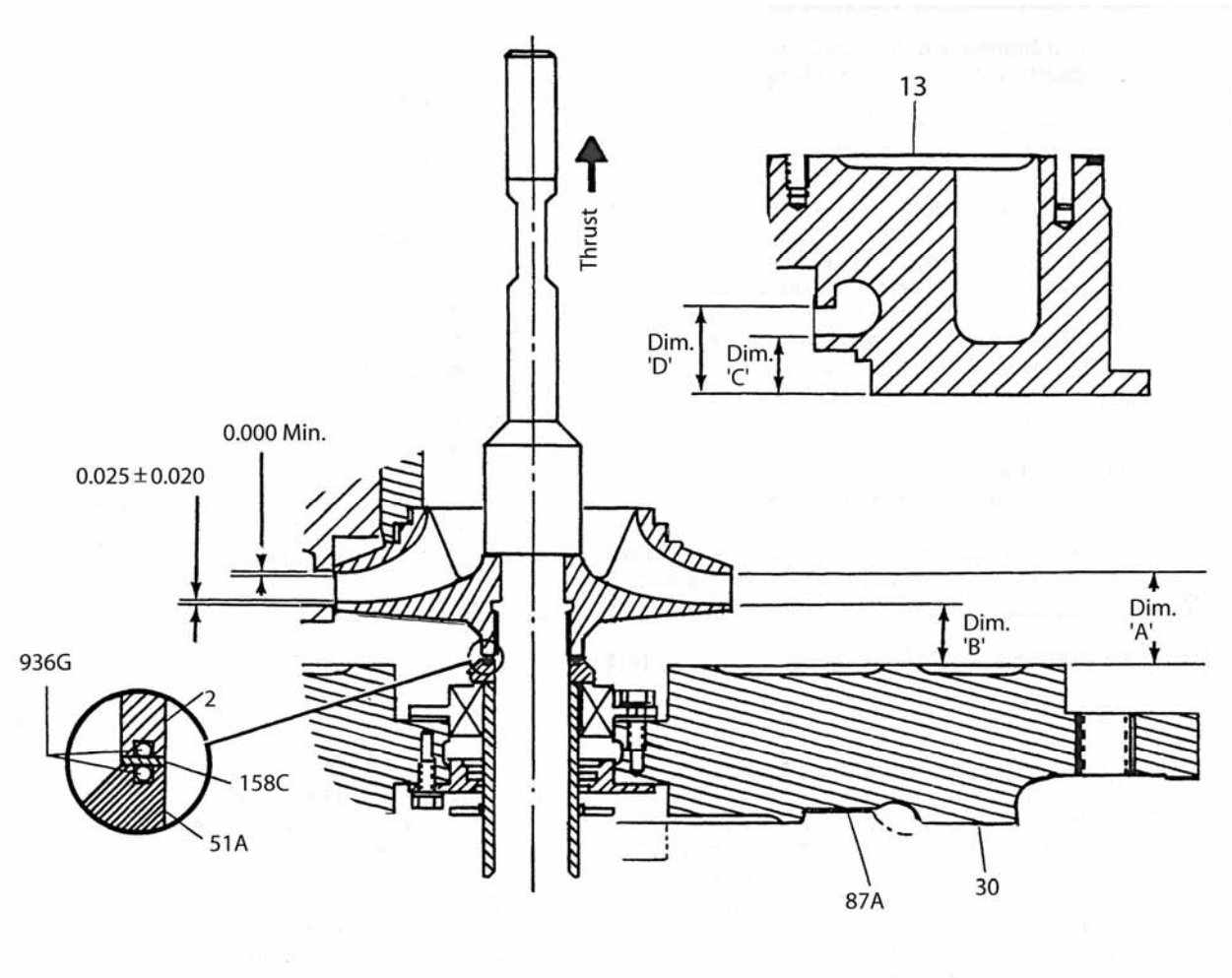


Figure 13. Shaft Loading Tool Installation

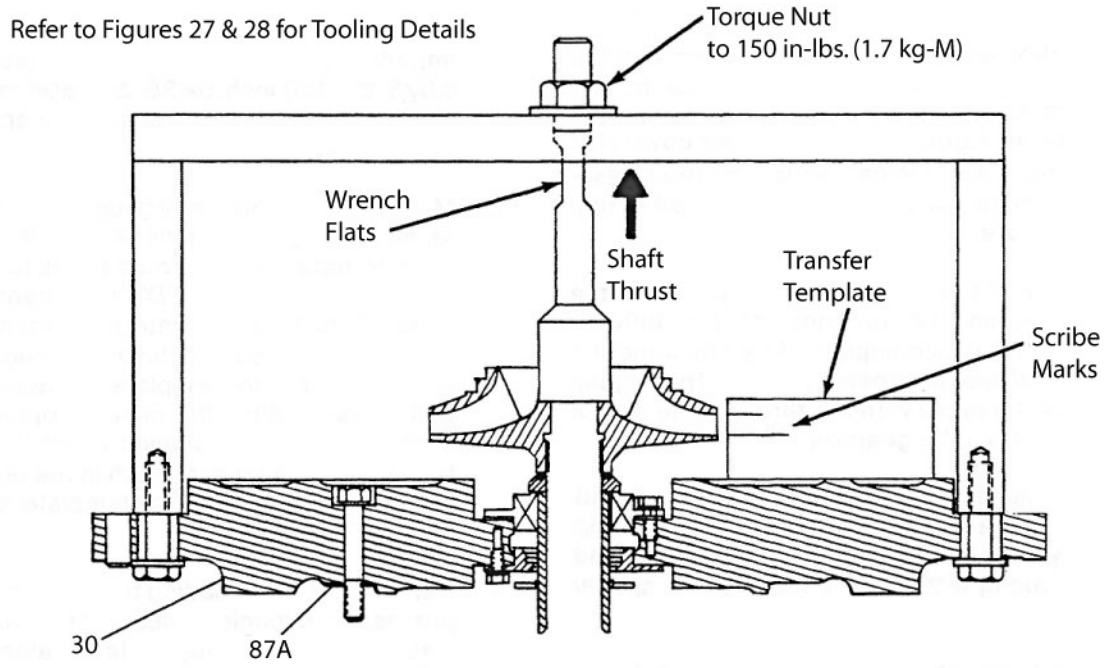


Figure 14. Inducer Housing Adjustment

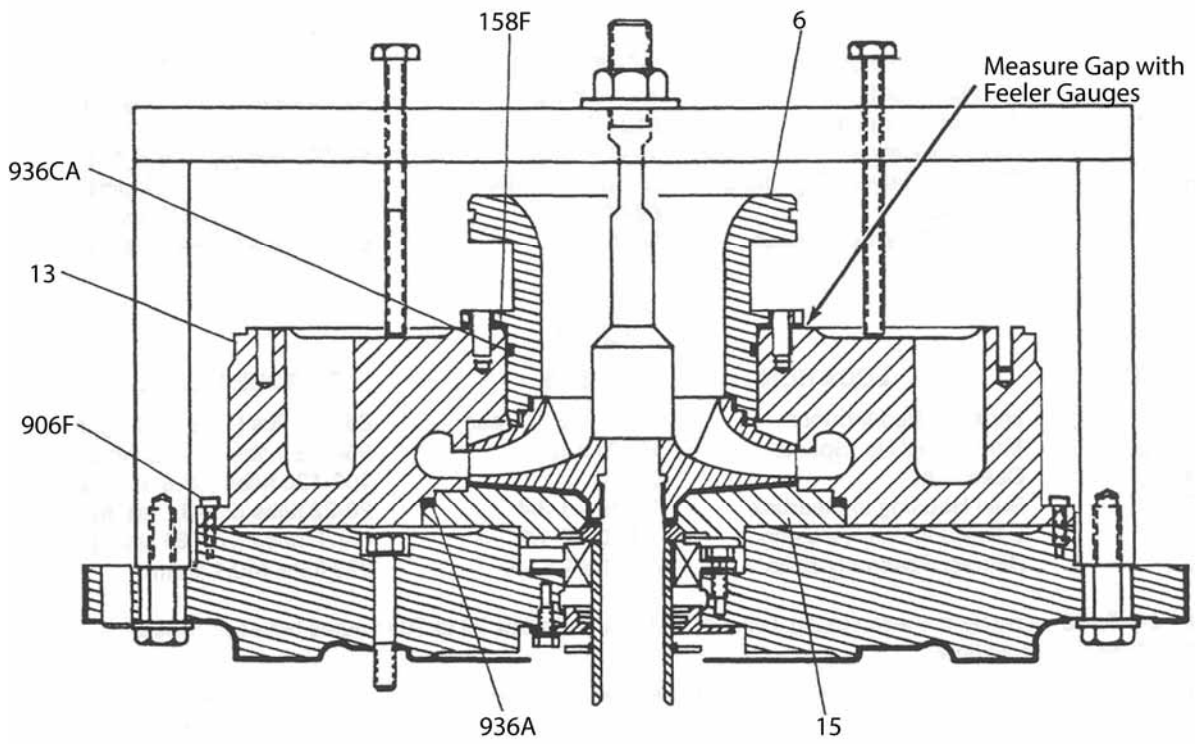
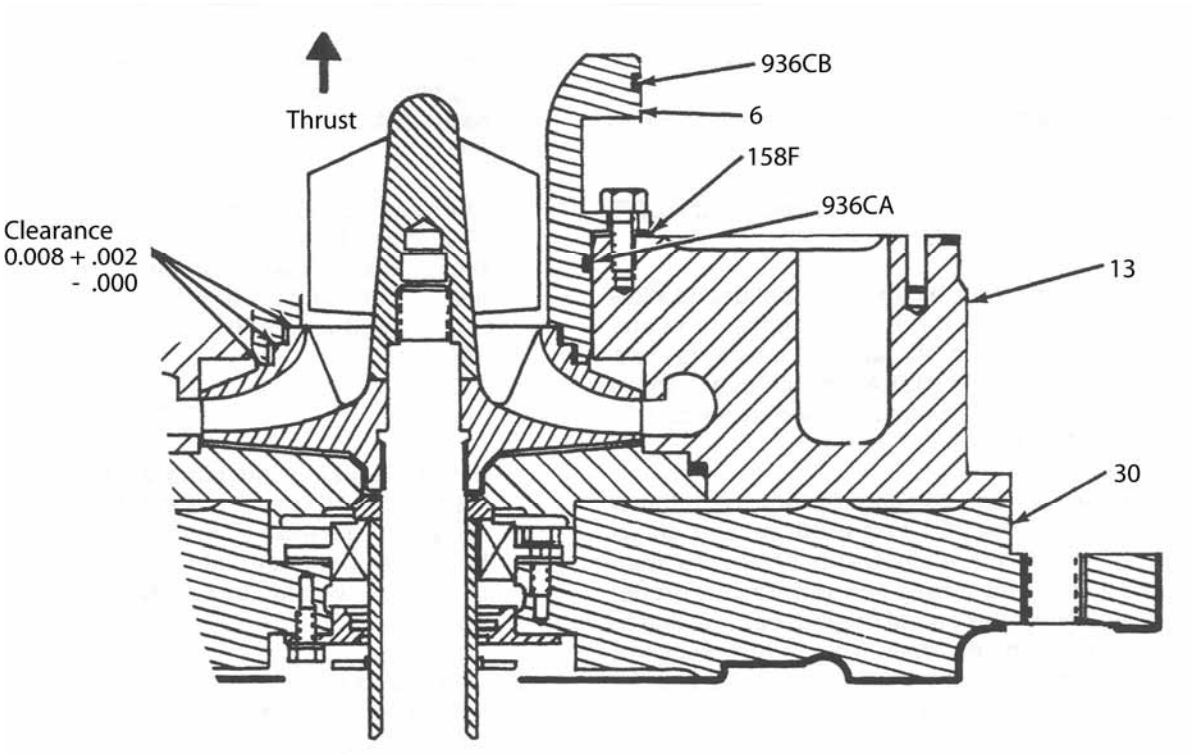


Figure 15. Inducer Housing Shim Adjustment



Procedure for Checking the High-Speed Shaft Endplay and Shoulder Height

The endplay of the shaft **MUST** be measured if any of the following parts have been replaced:

- High speed shaft assembly
- Thrust washer
- Output housing
- Journal bearing
- Bearing plate

Sundyne recommends checking endplay during any re-assembly.

To obtain correct shaft endplay shim spacers must be installed as required.

***Note**: All parts must be dry and free of oil.*

The output shaft assembly (A130) is dynamically balanced. Under most circumstances it does not require disassembly. Inspect the journal bearings and thrust runners for discoloration from overheating, also check for contact on the gear teeth.

Shims (158) are used beneath both high speed bearing assemblies (151A and B). The shims function is to provide both axial float (end play) and insure proper shaft extension. Both must be checked with the output shaft thrust towards the impeller. Dry bearings are required to make the adjustments. Any presence of oil under the thrust surfaces will produce inaccurate readings.

Step 1

Install the bearings (151A & B) without the shims in the output housing and bearing plate.

Step 2

Place the output housing on a raised surface with the open side up. Leave room for the input shaft to project through.

Step 3

Install the output shaft (A130) into the output housing bearing.

Step 4

Install the bearing plate. Be careful not to damage the thrust washer (155B). Leave out the idler shaft assembly (A140), gearbox gasket (105), and the o-ring (936T) from the gearbox split line. Install both of the alignment bolts (909C). Do not install the gearbox input housing. Clamp the bearing plate to the lower housing using “C” clamps or short bolts. This will insure a metal-to-metal fit.

Step 5

Turn the assembly over so the output shaft is extended upward. Load the output shaft toward the impeller (against bearing 151A). Measure the shaft extension dimension. A standard depth micrometer can be used if the gearbox seal rotating face (51D) is installed on the shaft. Determine the amount of shim to be used under bearing (151A). Shaft shoulder height should be 1.203” ± .005”.

Step 6

Install a dial indicator to measure the shaft axial float. This can be done inside or outside the gearbox. Take the total float reading and subtract the amount of shim to be used under the bearing (151A), then subtract 0.015 inch (desired end-float) from the total. The sum is the required thickness of the shim to be placed under the other bearing (151B).

Step 7

Shims supplied by Sundyne Corporation usually come in thicknesses of 0.005” to 0.010”. Select the shims that best obtain the shaft extension and end float dimensions.

Note: The axial float should be 0.015 ± .002 inches. It is preferred to have slightly more end float than slightly less end float.

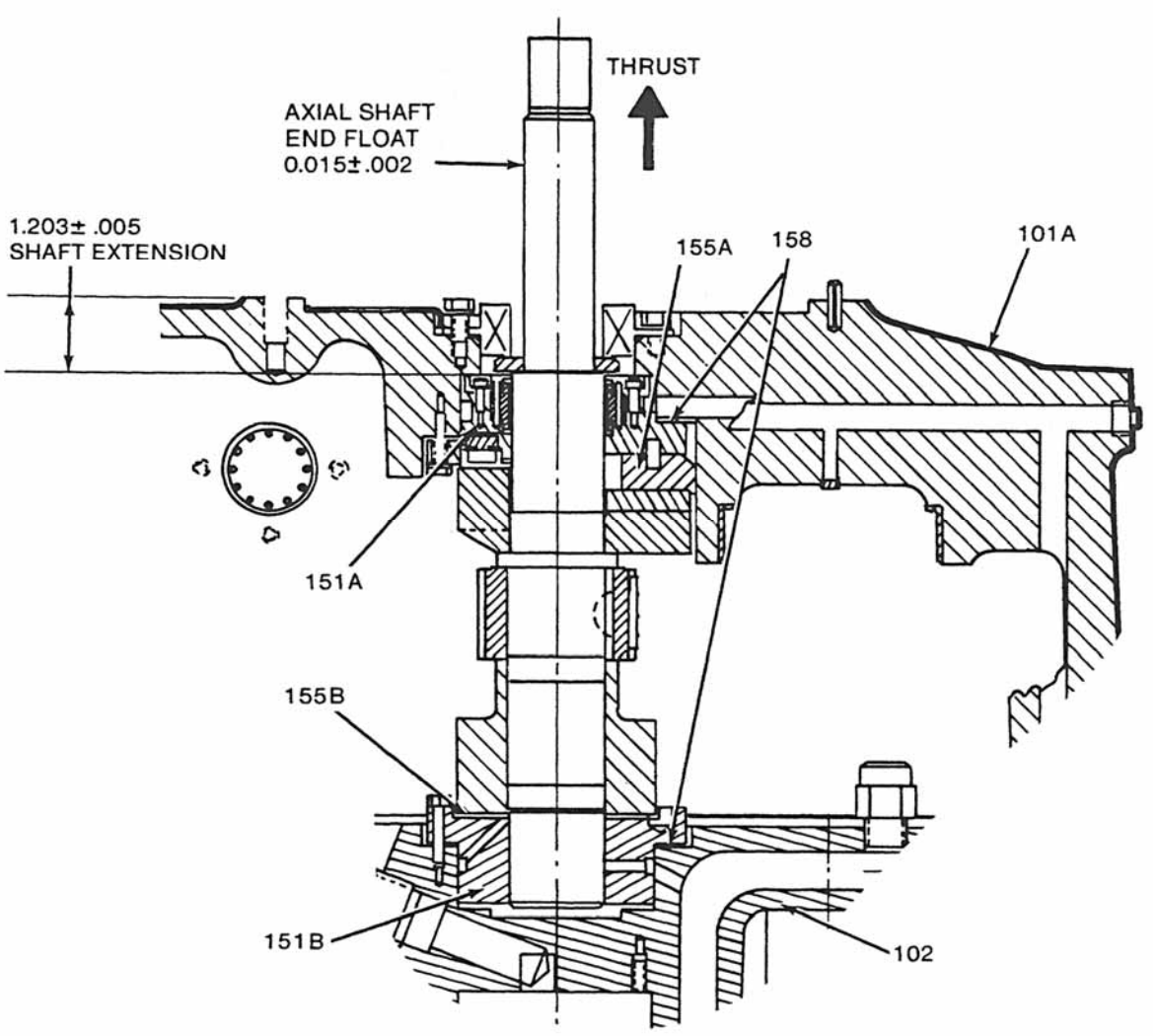
Step 8

Install the shims. Check both dimensions. Repeat the procedure if necessary.

Step 9

After proper shimming has been completed the gearbox can be reassembled. Do this by reversing the disassembly procedures.

Figure 16. Output Shaft Shim Adjustment



Note: *Shims (158) are adjusted to obtain noted shaft end float and noted shaft extension. Shaft extension must be checked with thrust in noted direction. Measurements are made with dry (no oil) bearings.*

Item No.	Part Name	QTY
101A	Gearbox Output Housing	1
102	Gearbox Bearing Plate	1
151A	Standard Capacity Tilt Pad Thrust Bearing/Journal Bearing	1
151B	Journal Bearing	1
155A	High Capacity Tilt Pad Thrust Bearing	1
158	Shims (As Required)	1

Assembly Clearance Data Sheet

CUSTOMER _____

SERIAL NUMBER _____

DATE _____

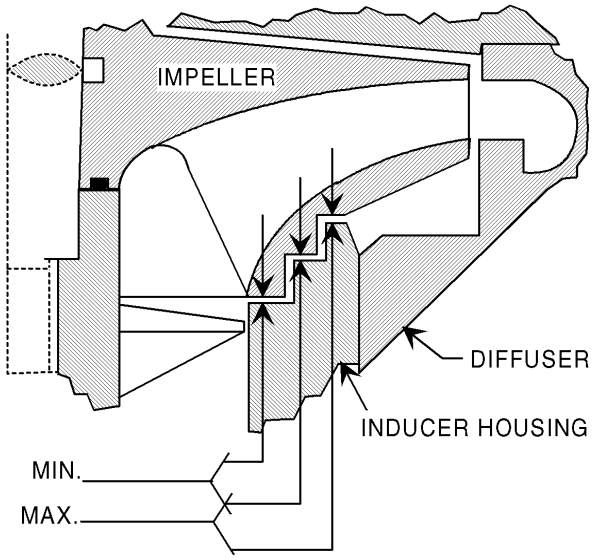
ASSEMBLER _____

Shim above high speed shaft SP01AA04
Item 158 _____

Shim below high speed shaft SP01AA04
Item 158 _____

High speed shaft end play
0.015" ± 0.002" _____

High speed shaft extension
1.203" ± 0.005" _____



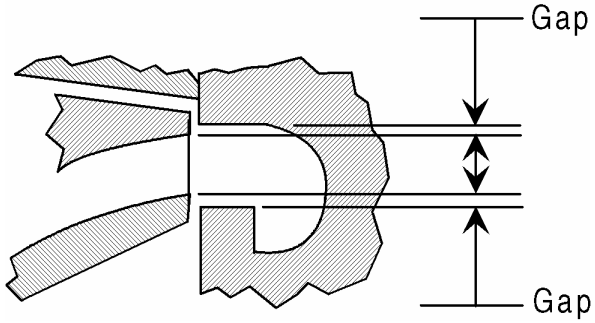
MINIMUM ALLOWABLE IMPELLER LABYRINTH CLEARANCE
0.010 + 0.005"
` - 0.000"

Impeller shim - SP01AK01
Item 158C _____

Inducer housing shim - SH06AK06
Item 158D _____

Diffuser Gap Maximum – 0.002"

Impeller Alignment



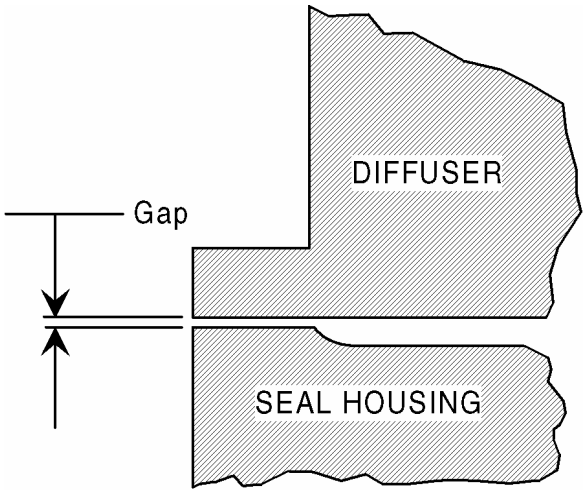
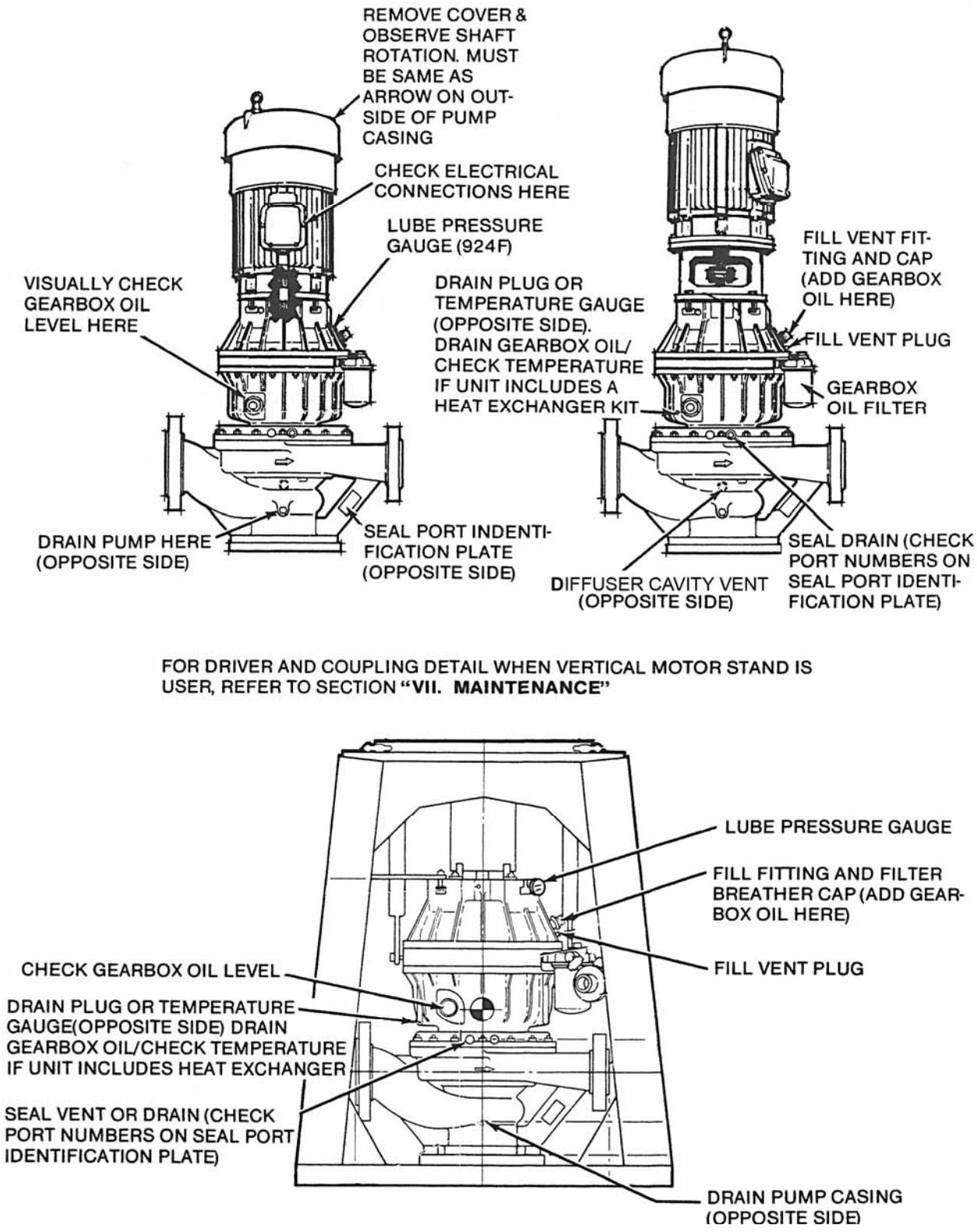


Figure 17. Service Check Points



Specialty Tools

Overhauling the Sundyne LMV 313 pump in the field requires a couple of specialty tools that are not generally needed while overhauling other Sundyne models. These specialty tools are recommended in order to simplify the overhaul procedure. These tools also provide more consistency in the setting of the high speed shaft loading and clearances. The following section will provide details on manufacturing these tools in the field as well as the use of these tools.

Shaft Loading Tool

The shaft loading tool is used to preload the shaft against the lower thrust bearing with an approximate 1000 pounds (453.6 kg) end load. This removes slack from the bearing stack-up. It also allows for more consistency in adjusting the impeller and inducer housing shims. See the following figures for details.

Pumps using the tapered inducer configuration do not require tool items 6, 7, and 8. This is due to the diffuser in these machines being bolted to the seal housing. To apply preload to the shaft, lay tool detail 1 across the open end of the inducer housing. (Refer to figure 19.)

It is vital that the mating surfaces of the diffuser and the seal housing are clean. Any high spots caused by nicks and dings must be removed so that errors will not be introduced during shimming and reassembly.

Figure 18. Shaft Loading Tool

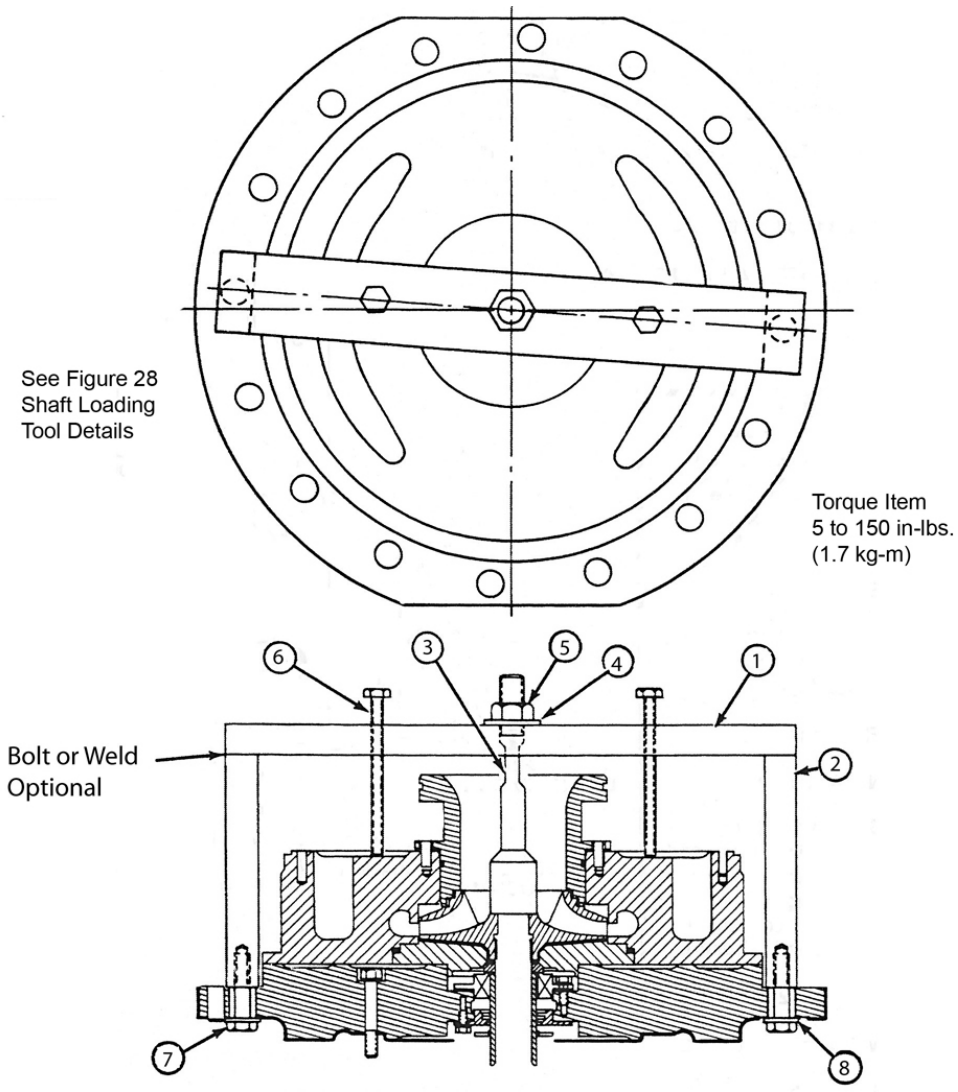
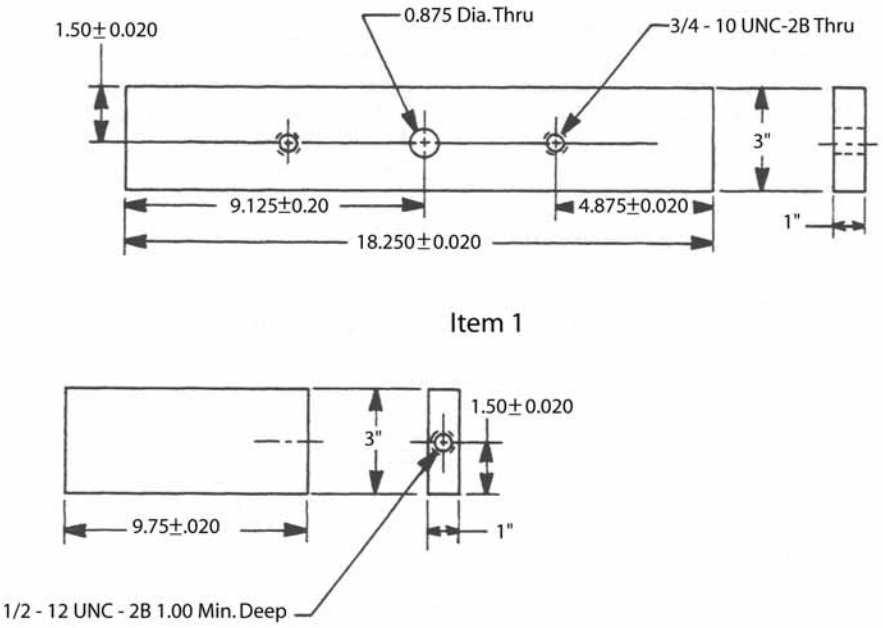
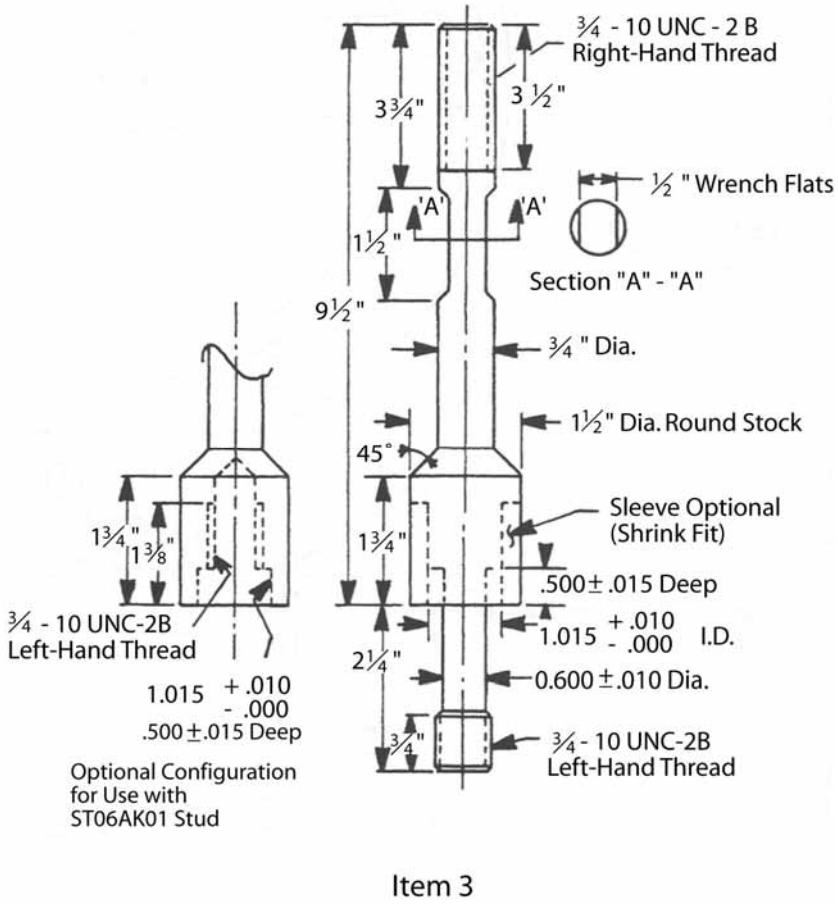


Figure 19. Shaft Loading Tool Details



Item	Description	Qty.
1	1 x 3 rectangle bar stock or 1 x 3 inch channel (steel)	1
2	Same as item 1	2
3	Tension bolt (loads impeller and rotating assembly)	1
4	Flat washer ¾”	2
5	Nut ¾-10 UNC	1
6	Bolt ¾-10 UNC, 8” long min. threaded full length. (Holds diffuser against seal housing. Not required with vaned diffuser.)	2
7	Bolt ½-12 UNC, 2” long (not required with vaned diffuser).	2
8	Flat Washer ½”	2



Impeller Locking Tool

The impeller must be kept from rotating when attempting to torque the inducer. The inducer must have 85-90 ft-lbs of torque (116-123 N-m) applied to it. The method of applying the torque varies depending on whether the inducer is straight or tapered.

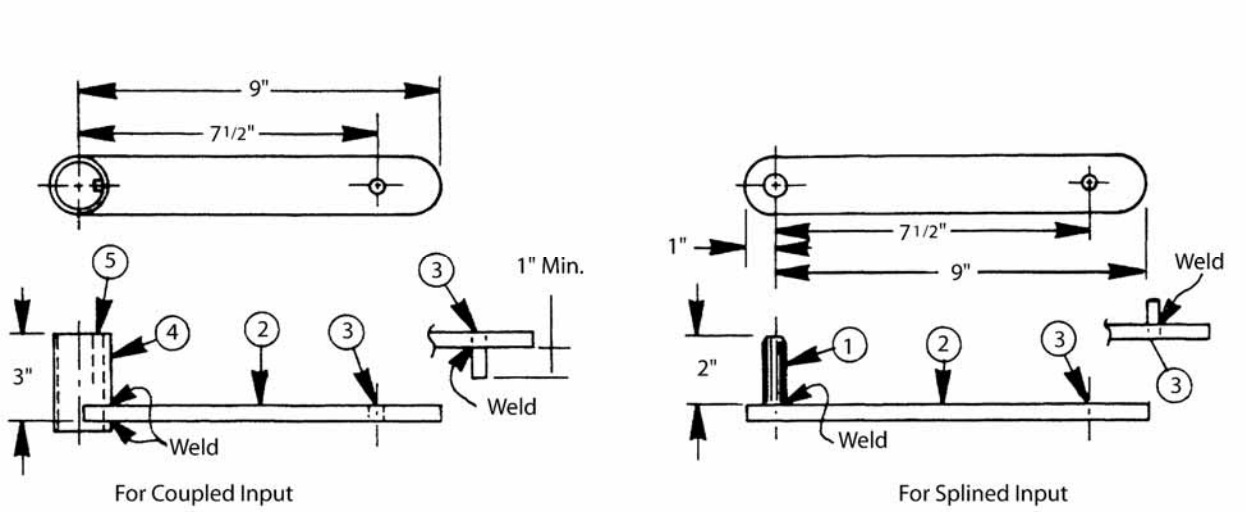
Straight Inducer

A strap wrench or hose clamp can be used to hold the impeller in place with a straight inducer. Fasten the tool around the impellers outside diameter and block it against rotation while the inducer is being torqued. The diffuser and inducer housing are then installed over the inducer and impeller.

Tapered Inducer

The tapered inducer must be installed only after the diffuser and inducer housing are in place. Do not lock the impeller by inserting a rod thru the diffuser discharge into the impeller. Risk of damaging the hardware is likely using this method. The correct method is to lock the input shaft. See the Input Shaft Locking Tool figure for details on the suggested tools for both the splined and coupled shaft configurations. The 90 ft-lb (123 N-m) inducer torque multiplied by the gearbox input/output will result in the torque at the input shaft when the inducer is tightened. This is usually 3 to 4 times the inducer torque and cannot be held by hand.

Figure 20. Input Shaft Loading Tool



① Segment from SH05AA0-8 Spline Shaft

② Steel Plate 2” wide x ½” Thick

③ ½” or ⅝” hole for bolt into “tee” slot or weld pin to plate

④ 1½” diameter schedule 40 pipe

⑤ ¼” Square Keystock (weld both ends)
(Note: The coupled input shaft is 1½” diameter and uses ⅜” square key.)

Falk Steelflex Type Coupling Specifications

Table1. Falk Steelflex Type Coupling Specifications

Falk Coupling Size	End Gap			Cover Bolt Torque
	Minimum	Normal	Maximum	
40T10	0.062 in. (1.57 mm)	0.125 in. (3.17 mm)	0.188 in. (4.77 mm)	100 in-lb (1.15 kg-m)
50T10	0.062 in. (1.57 mm)	0.125 in. (3.17 mm)	0.188 in. (4.77 mm)	200 in-lb (2.30 kg-m)
60T10	0.062 in. (1.57 mm)	0.125 in. (3.17 mm)	0.188 in. (4.77 mm)	200 in-lb (2.30 kg-m)
70T10	0.062 in. (1.57 mm)	0.125 in. (3.17 mm)	0.188 in. (4.77 mm)	200 in-lb (2.30 kg-m)
80T10	0.062 in. (1.57 mm)	0.125 in. (3.17 mm)	0.250 in. (6.35 mm)	200 in-lb (2.30 kg-m)

Falk Double Gear Type Coupling Specifications

Table 2. Falk Double Gear Type Coupling Specifications

Falk Coupling Size	End Gap			Operating Limits Total Indicator Reading		Bolt Torque
	Minimum	Normal	Maximum	Offset (Maximum)	Angular (Maximum)	
15G	0.140 in. (3.56 mm)	0.156 in. (3.96 mm)	0.172 in. (4.36 mm)	0.005 in. (0.127 mm)	0.005 in. (0.127 mm)	280 in-lb (3.22 kg-m)
20G	0.140 in (3.56 mm)	0.156 in. (3.96 mm)	0.172 in. (4.36 mm)	0.005 in. (0.127 mm)	0.005 in. (0.127 mm)	420 in-lb (4.83 kg-m)

Falk Double Gear Type-Vertical Specifications

Table 3. Falk Double Gear Type-Vertical Specifications

Falk Coupling Size	Operating Limits (Total Indicator Limit)		Bolt Torque
	Offset (Maximum)	Angular (Maximum)	
15GL 15GV	0.005 in. (0.127 mm)	0.005 in. (0.127 mm)	280 in-lb (3.22 kg-m)
20GL 20GV	0.005 in. (0.127 mm)	0.005 in. (0.127 mm)	420 in-lb (4.83 kg-m)

Thomas Type DBZ Coupling Specifications

Table 4. Thomas Type DBZ Coupling Specifications

Thomas Coupling Size	End Gap			Cover Bolt Torque
	Minimum	Normal	Maximum	
163	0.876 in. (22.24 mm)	0.938 in. (23.81 mm)	1.005 in. (25.41 mm)	156 in-lb (1.80 kg-m)
201	0.876 in. (22.24 mm)	0.938 in. (23.81mm)	1.005 in. (25.41 mm)	300 in-lb (3.46 kg-m)
226	1.126 in. (28.59 mm)	1.188 in. (30.18 mm)	1.251 in. (31.76 mm)	516 in-lb (5.95 kg-m)
263	1.219 in. (30.97 mm)	1.313 in. (33.35 mm)	1.407 in. (35.73 mm)	756 in-lb (8.72 kg-m)
301	1.406 in. (35.72 mm)	1.500 in. (38.10 mm)	1.594 in. (40.48 mm)	1140 in-lb (13.15 kg-m)

Thomas SN Spacer Type Vertical & Horizontal Coupling Specifications

Table 5. Thomas SN Spacer Type Vertical & Horizontal Coupling Specifications

Thomas Coupling Size	End Gap			Operating Limits Total Indicator Reading		Bolt Torque
	Minimum	Normal	Maximum	Offset (Maximum)	Angular (Maximum)	
SN226	0.563 in. (14.30 mm)	0.594 in. (15.09 mm)	0.625 in. (15.88 mm)	0.005 in. (0.127 mm)	0.005 in (0.127 mm)	516 in-lb (5.95 kg-m)
SN262	0.438 in. (11.13 mm)	0.469 in. (11.91 mm)	0.500 in (12.70 mm)	0.005 in. (0.127 mm)	0.005 in. (0.127 mm)	516 in-lb (5.95 kg-m)
SN312	0.469 in. (11.91 mm)	0.500 in. (12.70 mm)	0.531 in. (13.49 mm)	0.005in. (0.127 mm)	0.005 in. (0.127 mm)	756 in-lb (8.72 kg-m)

Gearbox Lube Oil Specifications

Table 6. Gearbox Lube Oil Specifications

Recommended Gearbox Lube Oil Specifications	
API Gravity	28 – 37
Pour Point, °C (°F)	-7 (20) max.
Flash Point, °C (°F)	204 (400) min.
Viscosity, cST at 40°C	28.8 to 35.2 (150/180 SSU @ 100°F)
Viscosity, CST at 100°C	5.2 (44 min. SSU @ 210°F
Viscosity, Index	95 minimum
ISO Viscosity Grade	32
Color, Maximum	
ASTM D 1500	1 to 5
Neut.Number, Maximum	0.20
Rust Protection	Pass
ASTM D 665, A & B	
Demulsibility	
ASTM D 1401	
Minutes to 0 ml emulsion -	
At 54°C (130°F) after 30 min.	Pass
At 82°C (180°F) after 60 min.	Pass
Foam Limits, ASTM D 892	
Sequence 1	25/0 max.
Sequence 2	50/0 max.
Sequence 3	25/0 max.
Note: No other additives are recommended.	

Gearbox and Pump Torque Values

Table 7. Gearbox and Pump Torque Values

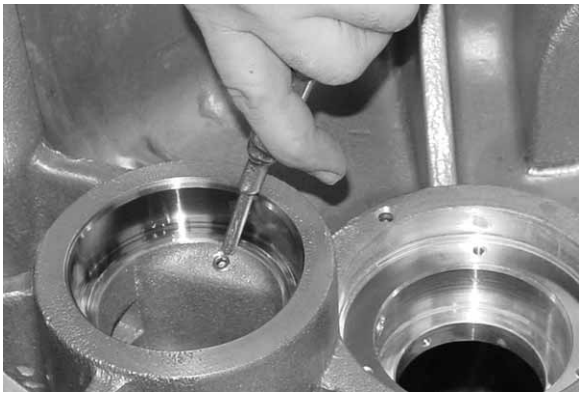
Gearbox ***Sundyne Standard Steel Screws & Bolts and NACE Compliant Steel Screws/Bolts (BG Material)***				
			Torque Values	
Item #	**Location**	**Size**	**English**	**Metric**
905H	Oil Filter Manifold	3/8 - 16 x 1/2	22 - 25 ft-lbs	30 - 34 N-m
905L	Gearbox Seal	1/4 - 20 x 1/2	75 - 80 in-lbs	8.5 - 9.0 N-m
905M, N	Journal Bearings	#10 - 24 x 1	35 - 40 in-lbs	4.0 - 4.5 N-m
905T	Chemical Barrier Gasket	1/4 - 20 x 5/8	75 - 80 in-lbs	8.5 - 9.0 N-m
909B	Gearbox Halves	1/2 - 13 x4	60 - 65 ft-lbs	81 - 88 N-m
909C	Gearbox Halves, Alignment	5/8 - 18 x 4 17/64	60 - 65 ft lbs	81 - 88 N-m
906B	Sight Glass	#8 - 32 x 1/2	10 - 12 in-lbs	1.0 - 1.4 N-m
Pumps & Compressors* ***Sundyne Standard Steel Screws and Bolts***				
			Torque Values	
Item #	**Location**	**Size**	**English**	**Metric**
3	Impeller Bolt/Inducer:			
	LMV/BMP-801, 802, 806, 322, 311, 331	1/2 - 20	36 - 40 ft-lbs	49 - 54 N-m
	LMV/BMP-341, 346	1/2 - 20	65 - 70 ft-lbs	88 - 95 N-m
	LMV-313, 343, BMP-338, 348 (High Flow)	3/4 - 10	85 - 90 ft-lbs	115-122 N-m
	LMC/BMC 3X1P, 3X1F, 3X3, 3X6P, 3X7	1/2 - 20	36 - 40 ft-lbs	49 - 54 N-m
906D	Diffuser Attaching Screws	1/4 - 20	95 - 102 in-lbs	11 - 11.5 N-m
905E	Mechanical Seal No. Spacer	1/4 - 20 x 12	95 - 102 in-lbs	11 - 11.5 N-m
905F	Throttle Bushing/Mechanical Seal	1/4 - 20 x 12	9 5- 102 in-lbs	11 - 11.5 N-m
905G	Double Seal with Spacer	1/4 - 20 x 3/4	95 - 102 in-lbs	11 - 11.5 N-m
914A	Case Nuts	3/4 - 10	250 - 275 ft-lbs	340 - 375 N-m
914A	Case Nuts	7/8 - 9	300 - 330 ft-lbs	405 - 445 N-m
905A	Seal Housing to Gearbox	3/8 - 16 x 1 3/4	35 - 40 ft-lbs	47 - 54 N-m
905P	Separator	1/4 - 20 x 5/8	95 - 102 in-lbs	11 - 11.5 N-m
Pumps & Compressors ***NACE Compliant Steel Screws / Bolts (BG Material)***				
			Torque Values	
Item #	**Location**	**Size**	**English**	**Metric**
3	Impeller Bolt/Inducer:			
	LMV/BMP-801, 802, 806, 322, 311, 331	1/2 - 20	36 - 40 ft-lbs	49 - 54 N-m
	LMV/BMP-341, 346	1/2 - 20	65 - 70 ft-lbs	88 - 95 N-m
	LMV-313, 343, BMP-338, 348 (High Flow)	3/4 - 10	85- 90 ft-lbs	115 - 122 N-m
	LMC/BMC 3X1P, 3X1F, 3X3, 3X6P, 3X7	1/2 - 20	36 - 40 ft-lbs	49 - 54 N-m
906D	Diffuser Attaching Screws	1/4 - 20	70 - 75 in-lbs	8.0 - 8.5 N-m
905E	Mechanical Seal No. Spacer	1/4 - 20	70 - 75 in-lbs	8.0 - 8.5 N-m
905F	Throttle Bushing/Mechanical Seal	1/4 - 20	70 - 75 in-lbs	8.0 - 8.5 N-m
905G	Double Seal with Spacer	1/4 - 20	70 - 75 in-lbs	8.0 - 8.5 N-m
914A	Case Nuts	3/4 - 10	160 - 200 ft-lbs	217 - 270 N-m
914A	Case Nuts	7/8 - 9	225 - 245 ft-lbs	305 - 332 N-m
905A	Seal Housing to Gearbox	3/8 - 16 x 1 3/4	27 - 30 ft-lbs	47 - 54 N-m
905P	Separator	1/4 - 20 x 5/8	70 - 75 in-lbs	8.0 - 8.5 N-m

* When using Teflon® o-rings, allow 15 minutes between torquing for the Teflon® to cold flow. Repeat torquing until there is no change in torque.

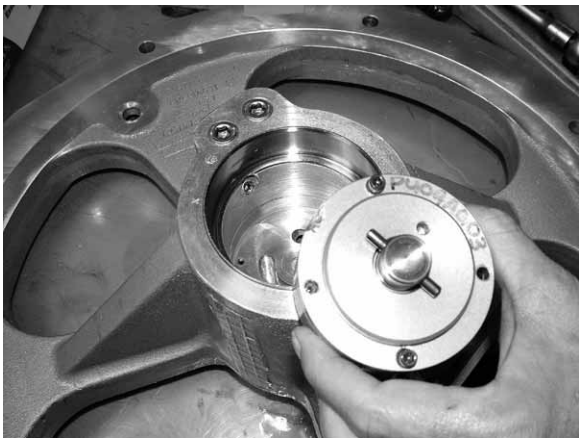
Reassembling the LMV-313

STEP 1

Install all lube jets.



Install all plugs and install the lube pump in the bearing plate.



STEP 2

Insert shim under lower journal bearing.

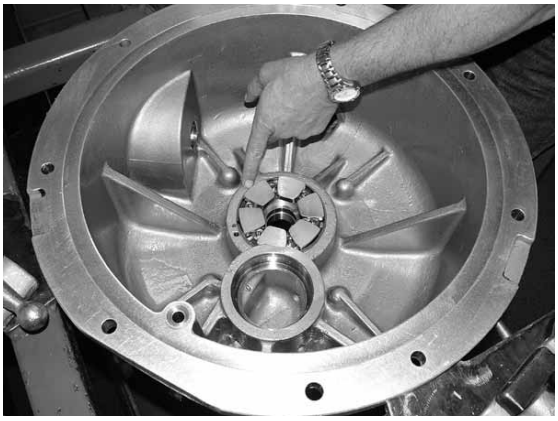
STEP 3

Install lower journal bearing.

***Note**: Torque to 28-31 in-lbs.*

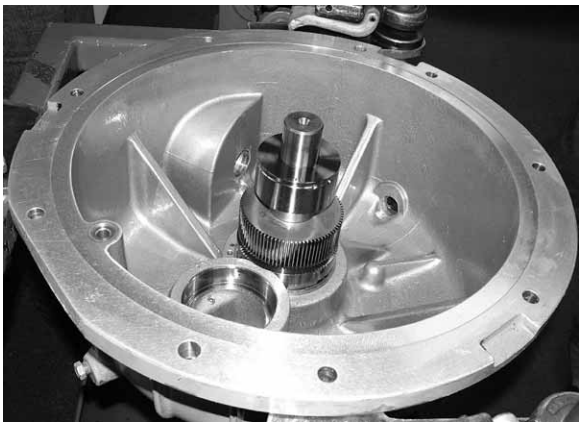
Step 4

Install tilting pad thrust bearing.



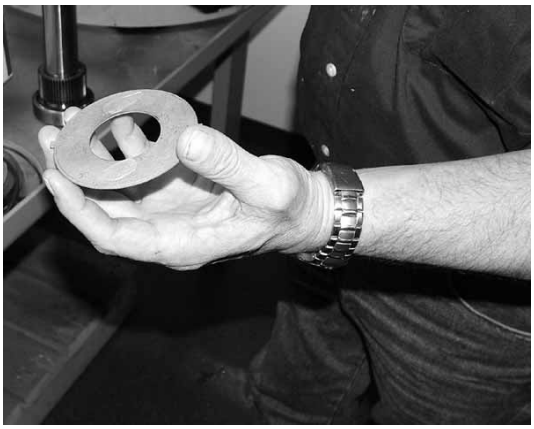
STEP 5

Install high-speed shaft assembly dry.



STEP 6

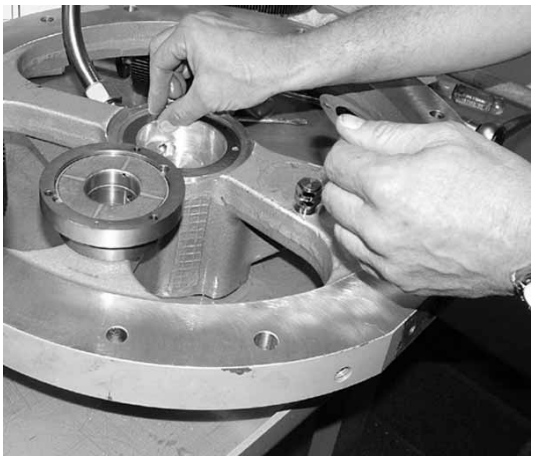
Install upper thrust washer onto the upper journal bearing.



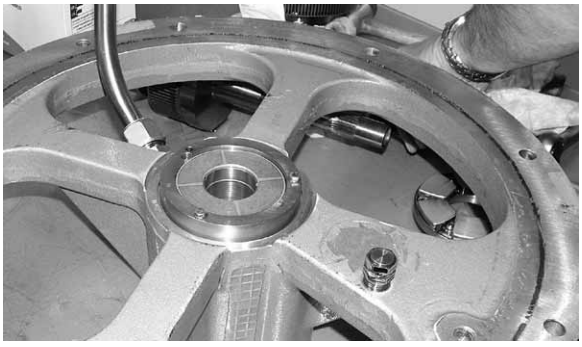
***Note**: Use a small amount of petroleum jelly to hold washer in place.*

STEP 7

Install shim.



Re-install the upper journal bearing into the bearing plate.



***Note**: Torque hex head screws to 35-40 in-lbs.*

STEP 8

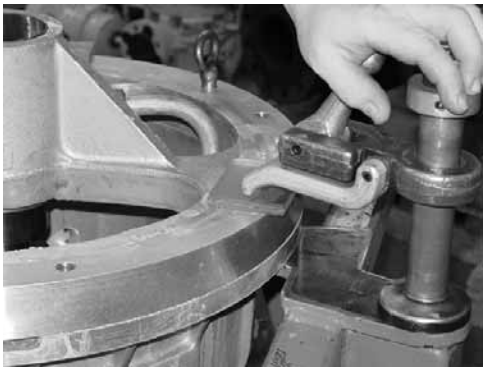
Install bearing plate onto the lower housing without gasket or o-ring.

STEP 9

Use alignment bolts to align the bearing plate.

STEP 10

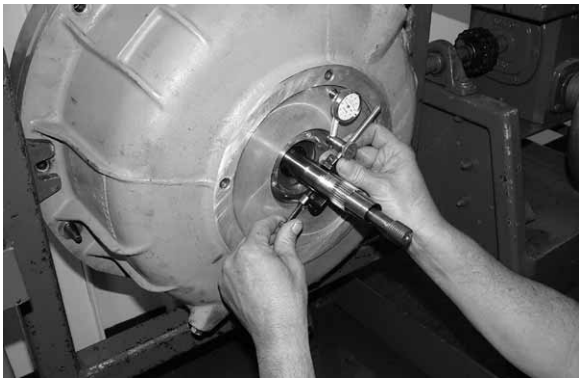
Clamp bearing plate to the lower gearbox housing.



***Note**: "C" clamps can be utilized to perform this task. Be sure to protect the housing faces from any clamping damage.*

STEP 11

Inspect endplay of the high-speed shaft.



***Note**: Endplay must fall within these tolerances, (.015" +/- .002")*

Note: *For complete instructions for checking endplay and shaft shoulder height see the Procedure for Checking High-Speed Shaft End Play and Shoulder Height in this manual.*

STEP 12

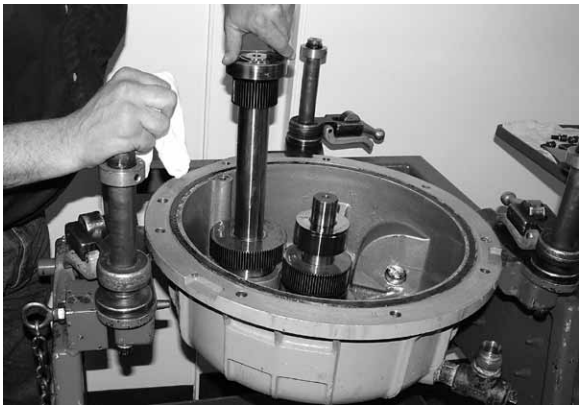
With rotating face installed, check shaft shoulder height using a depth micrometer.

Note: *Tolerances for shaft shoulder height are 1.203 ± 0.005*

Once the correct endplay is confirmed, install the housing gasket and o-ring in the lower housing. Pre-lubricate the shafts and bearings from this point in assembly.

STEP 13

Install idler shaft and high-speed shaft assembly.



STEP 14

Install the bearing plate, gasket and o-ring.

STEP 15

Install the input shaft.

STEP 16

Install upper gearbox housing.

STEP 17

Install the two alignment bolts, turning the nuts but not the bolts. Then install the remaining housing bolts.

STEP 18

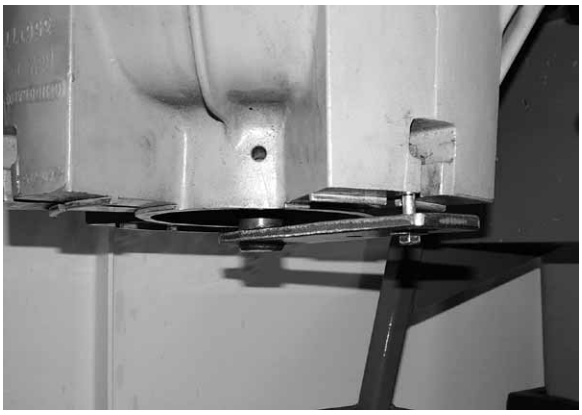
Install the fill and vent fitting.

STEP 19

Install the vent cap.

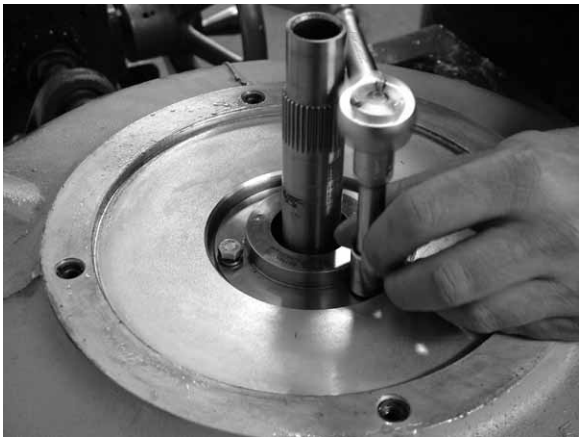
STEP 20

Install the anti-rotation tool.



STEP 21

Install the gearbox seal rotating face, gearbox seal, and o-ring 936P.



STEP 22

Install upper shaft sleeve and o-ring 936K.

Install o-ring 936J.

Note: *If using Teflon or graphoil o-rings, do not install any of the o-rings until all measurements have been taken,*

STEP 23

Install thermal barrier gasket.

STEP 24

Install upper process seal and o-ring 936H onto seal housing.

Note*: Torque hex head screws to 95-102 in-lbs.*

STEP 25

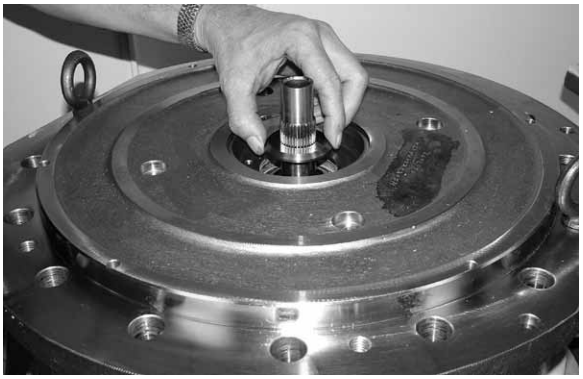
Install the seal housing.

Note*: Before installing the seal housing insert the bolts for the seal housing into holes and temporarily install nuts on them to hold in place. It is very difficult to insert the bolts after the seal housing has been installed onto the gearbox.*

Note: *Torque seal housing bolts to 35-40 ft-lbs.*

STEP 26

Install upper process seal rotating face.



Note: *Torque process seal hex head screws to 95-102 in-lbs.*

STEP 27

Install the lower process seal shaft sleeve. Install two 936J o-rings, one on the top of the sleeve and one on the bottom.

STEP 28

Install the lower process seal and 936H o-ring.

STEP 29

Install lower mating ring, o-ring 936G, and impeller spacer 158C.

STEP 30

Install impeller o-ring 936G.

Note*: Use petroleum jelly to hold the o-ring in position.*

STEP 31

Install the impeller and 936F o-ring.

***Note**: The diffuser cover is not installed for this step.*

STEP 32

Install the shaft-loading tool.

***Note:** Torque values are shown on the tool. 25 ft-lb for standard tilt pad thrust and 50 ft-lb for high thrust glacier bearings.*

***Note:** Refer to the Specialty Tools section later in this manual for additional information on the shaft loading tool.*

Apply anti-seize to the inducer stud.

Fully thread inducer stud into inducer loading tool.

***Note:** Inducer stud is left hand thread.*

Thread inducer stud and inducer loading tool into shaft end.

Torque shaft loading tool.

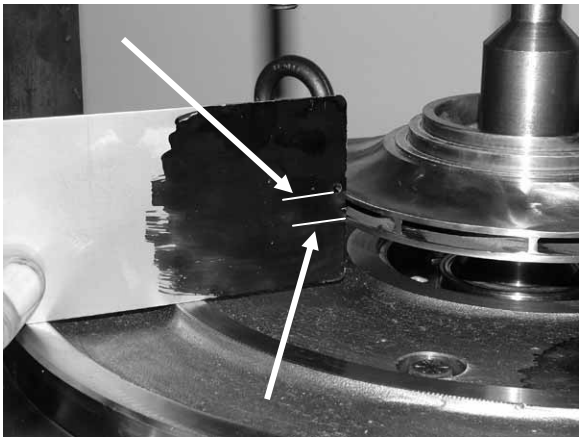
STEP 33

Measure the diffuser opening using a depth micrometer. Transfer these readings to a template.

Note: *Refer to Pump Assembly and Clearance Adjustments section later in this manual for additional information.*

STEP 34

Use measurement of diffuser to ensure that the openings will line up with the openings in the impeller by changing the impeller shimming as necessary.



Note: *An Assembly Clearance Data Sheet is provided later in this manual to record your measurements.*

STEP 35

Remove the impeller and shaft loading tool and install the diffuser cover and o-ring 936E.

STEP 36

Install impeller and o-ring 936A.

STEP 37

Install eyebolts into the diffuser.

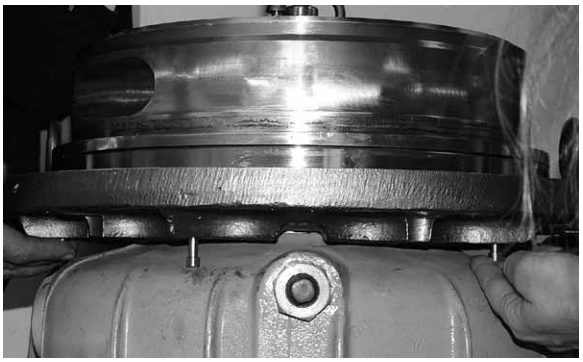
STEP 38

Install the diffuser onto the seal housing.

***Note**: Offset bolt pattern.*

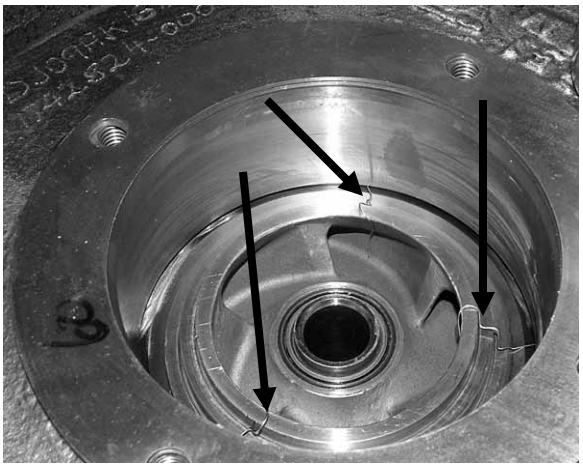
STEP 39

Install diffuser mounting bolts.



STEP 40

Install soft solder over the steps of the impeller.



STEP 41

Install the inducer housing, shims, and o-rings 936C and 936CA.

***Note:** Ensure that the inducer tool doesn't rotate while torque is applied on the loading tool.*

STEP 42

Install shaft loading tool to fully extend the shaft, torque the shaft and then loosen tool.

STEP 43

Remove the shaft loading tool and the inducer housing. Measure the pieces of solder to determine if the amount of gap is within tolerances (0.010" +.005"/-.000").

STEP 44

Install the correct shims to maintain the tolerance in the last step. Then install the inducer housing and o-rings 936CA and 936C.

Note: *Return to step 26 if using Teflon or graphoil o-rings.*

STEP 45

Fully thread inducer stud into inducer and install inducer into inducer housing.

Note*: Torque inducer stud to 85-90 ft-lbs.*

STEP 46

Rotate the gearbox.

STEP 47

Install T-hooks for lifting the gearbox.

STEP 48

Lift gearbox up and position over the pump case. Install o-rings 936B, 936CB, and backing ring 70B.

STEP 49

Lower the gearbox onto pump casing.

Note: *Before operating the pump, ensure that the diffuser cavity vent is open.*

TROUBLESHOOTING

Gearbox & Pump Diagnostics

Several system factors may affect the performance of the pump. These factors are:

- Temperature
- Specific gravity
- Suction pressure
- Driver speed
- Flow rate
- Control characteristics

These factors as well as internal problems must be considered when analyzing pump system performance. The following table gives diagnostic information that can be useful when analyzing gearbox and pump performance problems.

Table 8. Gearbox and Pump Diagnostics

Situation/Symptom	Possible Cause	Investigative/Corrective Action
No flow, no pressure at start-up.	Pump not completely filled with liquid.	Bleed all vapor or air from port 6. Allow more cool-down time if pumping low temperature fluid. Check suction line for air leak if suction pressure is lower than atmospheric.
	NPSH actually lower than NPSH requirement listed on specification sheet.	Suction line blocked – check suction screen and valve. Excessive pressure drop through suction piping. Flow restricted by vapor pockets in high points of suction line. Suction tank level or pressure too low. Entrained air or vapor in pumped fluid. NPSH reduced by presence of more volatile fluid in process fluid.
	Failure of drive component, such as interconnecting shaft or impeller key, or item missing from assembly.	Disassemble and inspect.
	Reverse direction of rotation.	Direction of driver shaft rotation must be as shown by arrow on pump casing. Note: Impeller and driver rotate in the same direction.
Insufficient total head.	Flow too high.	Check total head and flow rate against performance curve.
	Wrong direction of driver shaft rotation. (It is possible for the pump to develop greater than 50 percent design total head in this condition).	Direction of driver shaft rotation must be as shown by arrow on pump casing. Note: Impeller and driver rotate in the same direction.
	NPSH actually lower than NPSH requirement listed on specification sheet.	Refer to solutions listed under “No flow, no pressure at start-up”.
	Excess clearance at impeller face (applicable to high flow models, 313/333/343/348.	Disassemble and check for clearance.
	Flow too low, causing overheating of fluid resulting in internal boiling and unstable pump operation.	Increase through-flow rate. Bypass part of pump discharge to supply tank.

Situation/Symptom	Possible Cause	Investigative/Corrective Action
Insufficient total head cont.	Diffuser discharge throat partially plugged or impeller damaged by passage of a solid particle.	Clean these areas of all obstructions and restore surfaces to a smooth polished finish free of all corrosion pitting. Edge of diffuser throat must be sharp.
	Corrosion and/or erosion of diffuser throat (may also be accompanied by corrosion/ erosion of diffuser and cover surface adjacent to impeller).	If edge of throat is no longer sharp and smooth or has opened in size, head-rise may be reduced. Opening of the inlet area of the throat will result in higher flow rate and horsepower consumption. Corrosion/erosion of diffuser and cover surfaces will result in a significant horsepower increase.
	Excessive recirculation from discharge to inlet.	Check flow through external plumbing. Pump o-ring (936C) damaged or missing. Integral centrifugal separator orifice worn.
	Process fluid specific gravity or viscosity different from values shown on specification sheet.	Check actual viscosity and specific gravity at operating temperature. Viscosity higher than five centipoise will cause reduced head and flow and increased power consumption.
	Driver speed too low.	Check speed against value listed on specification sheet.
	Pressure gauges or flow meters in error	Calibrate instrumentation.
Driver overloaded.	Fluid specific gravity or viscosity higher than values listed on specification sheet.	Check actual viscosity and specific gravity against value listed on specification sheet.
	Electrical failure in electric driver.	Check circuit breaker heater size and setting. Check voltage and voltage balance between phases. Current for each phase should be balanced within three percent.
	Mechanical failure in driver, gearbox or pump.	Remove driver and check for freedom of rotation, correct spacing of pump and gearbox shaft assemblies. Remove fluid end and search for any mechanical failure. Remove gearbox oil level sight glass and inspect bottom of sump for wear particles. Bearings are probably not damaged if no wear particles are present.
	Corrosion pitting on surface of diffuser cover or diffuser, adjacent to impeller blades. Head rise is also reduced by this condition.	Disassemble pump and inspect. Rough or pitted surfaces can cause friction losses which will significantly increase horsepower consumption. Clean these areas of all obstruction and restore surfaces to a smooth polished finish. Check diffuser throat area at the inlet; erosion or corrosion resulting in roughness or increased area will increase horsepower consumption. Note: A larger throat size than design will allow a higher flow and horsepower for a given head rise.
Excessive discharge pressure pulsations.	Flow rate too low.	Increase flow rate through pump. Add bypass to suction tank if necessary.
	Insufficient NPSH available.	Refer to solution for insufficient NPSH under “No flow, no pressure at startup,” above.
	Defective flow control valve.	Check control valve.

Situation/Symptom	Possible Cause	Investigative/Corrective Action
Change of gearbox oil from normal color to milky pink or yellow	Gearbox oil contaminated with water or process fluid.	Inspect gearbox heat exchanger for leakage. Check for excessive pump seal leakage. Inspect shaft sleeve o-rings. Inspect that seal housing port 1 and other seal drains are open for unrestricted seal leakage flow.
Shaft sleeve rubs on inside diameter of seal.	Gearbox journal bearing failure.	Install replacement exchange gearbox or repair gearbox as outlined under “Maintenance”
Excessive gearbox oil consumption.	Low speed shaft seal (115) leakage.	Check drain port for leakage. Replace shaft seal if required.
	High speed shaft mechanical seal (60C) leakage.	Check upper gearbox housing drain port for leakage. Replace shaft seal if required.
	Leakage through heat exchanger into cooling fluid.	Pressure test heat exchanger and replace if required.
Excessive oil foaming.	High oil level.	Shut down the unit and check oil level.
	Low gearbox temperature. Incorrect lubricant.	Adjust coolant to heat exchanger, keeping oil temperature above 140°F, 60°C.
High gearbox temperature.	Heat exchanger fouled or coolant shut off. Oil level too high.	Check coolant flow and/or clean heat exchanger. Check oil level and adjust.

Pump Mechanical Seal Diagnostics

The following table contains diagnostic information that is applicable to single seal, double seal, and tandem seal equipped units.

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Repair procedures for mechanical seals are listed in this manual under Maintenance

Table 9. Pump Mechanical Seal Diagnostics

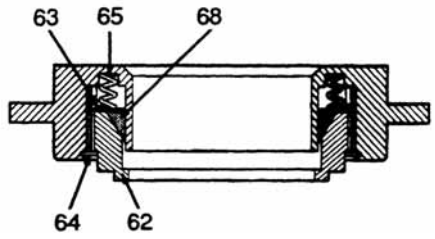
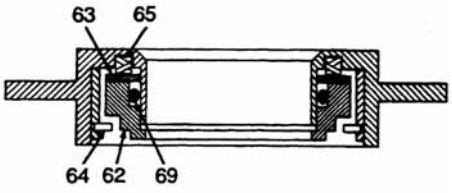
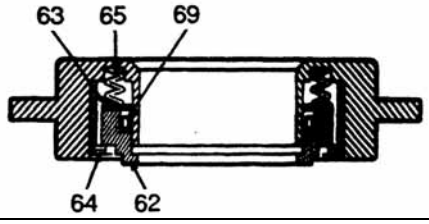
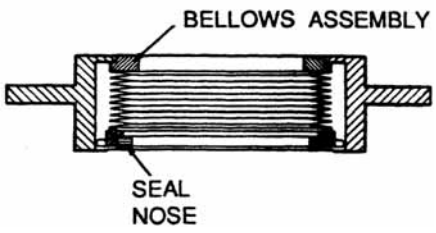
Situation/Symptom	Possible Cause	Investigative/Corrective Action
Sudden increase in seal leakage.	Severe cavitation or loss of suction causing vibration and bouncing of seal face.	Correct pump suction condition causing cavitation. Bleed vapor from seal cavity and restart. Install double seal if loss of suction cannot be prevented.
	Seal icing on low temperature pumps or icing when handling fluids which vaporize at a temperature of less than +32°F (0°C) at atmospheric pressure	Quench with compatible fluid which will not freeze at pump temperature through seal drain port 2 or 7 to prevent ice formation on atmospheric side of seal during start-up and in running condition. Use purge of dry nitrogen gas through ports 2 or 7. Install double or tandem seal if ice is caused by water in process fluid or supply external seal flush of compatible fluid which does not contain water.
	Solid particles in seal cavity or seal spring area (seal faces usually have rough scratched appearance).	Inspect for clogged integral centrifugal separator orifices. Clean orifices if necessary (plan 31 if so equipped.) Supply external clean seal flush or double seal if particles cannot be removed by separator.
	Seal stationary face spring action is rough and sticky.	If parts are corroded, replace with parts made from compatible materials. If formation of solids causes sticky seal analyze fluid properties. Use external seal flush or double seal arrangement.
	Worn or damaged seal.	Disassemble seal and rebuild or replace per instructions in maintenance section.
	Wear pattern on seal rotating faces not uniform.	Lightly lap surfaces of shaft sleeve and impeller hub which contact rotating seal face to remove high spots. Install new seal faces.
	Wear pattern on stationary face smooth but not uniform.	Lap flat or replace seal.
	Edges of stationary face chipped and seal face worn. (Vapor flashing in seal cavity will cause excessive wear and/or cracking of rotating face.)	Install seal cavity bypass to suction tank. Prevent loss of pump suction. Supply cool seal flush. Install double seal.
Sudden increase in seal leakage cont.	Seal rotating face cracked or broken. May be caused by damage at assembly or thermal shock caused by seal running dry.	Prevent loss of pump suction or supply continuous external seal flush. Install double seal.

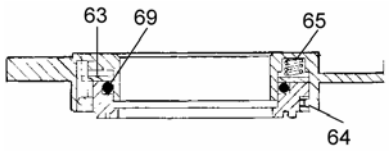
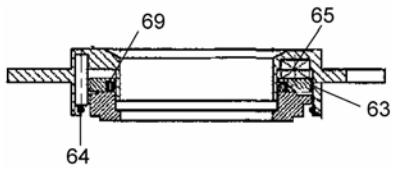
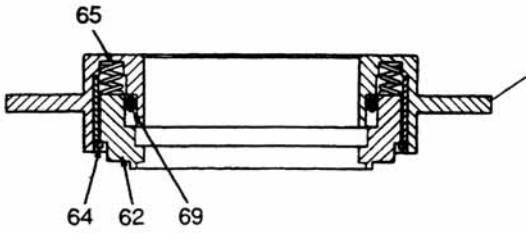
Situation/Symptom	Possible Cause	Investigative/Corrective Action
	Chemical attack of seal faces, seal parts or o-rings.	Investigate fluid properties and determine suitable materials for replacement.
	Excessive radial high speed shaft movement. Bent high speed shaft or severe out-of-balance.	Check high speed shaft journal bearings and replace if necessary. Check if damage exists on impeller and/or inducer which will indicate that a large particle went through the pump. Deposits on the impeller/inducer causing unbalance.
	Damage to mechanical seal secondary seal (Teflon® wedge or U-cup or elastomer o-ring).	Check for erosion and/or corrosion attack. Install seal flush or double seal arrangement.
	Loose stack-up of high-speed shaft attaching components.	Check for correct impeller bolt/inducer torque. Check for cold flow of Teflon® o-rings.

DRAWINGS & PARTS LISTING

Mechanical Seals

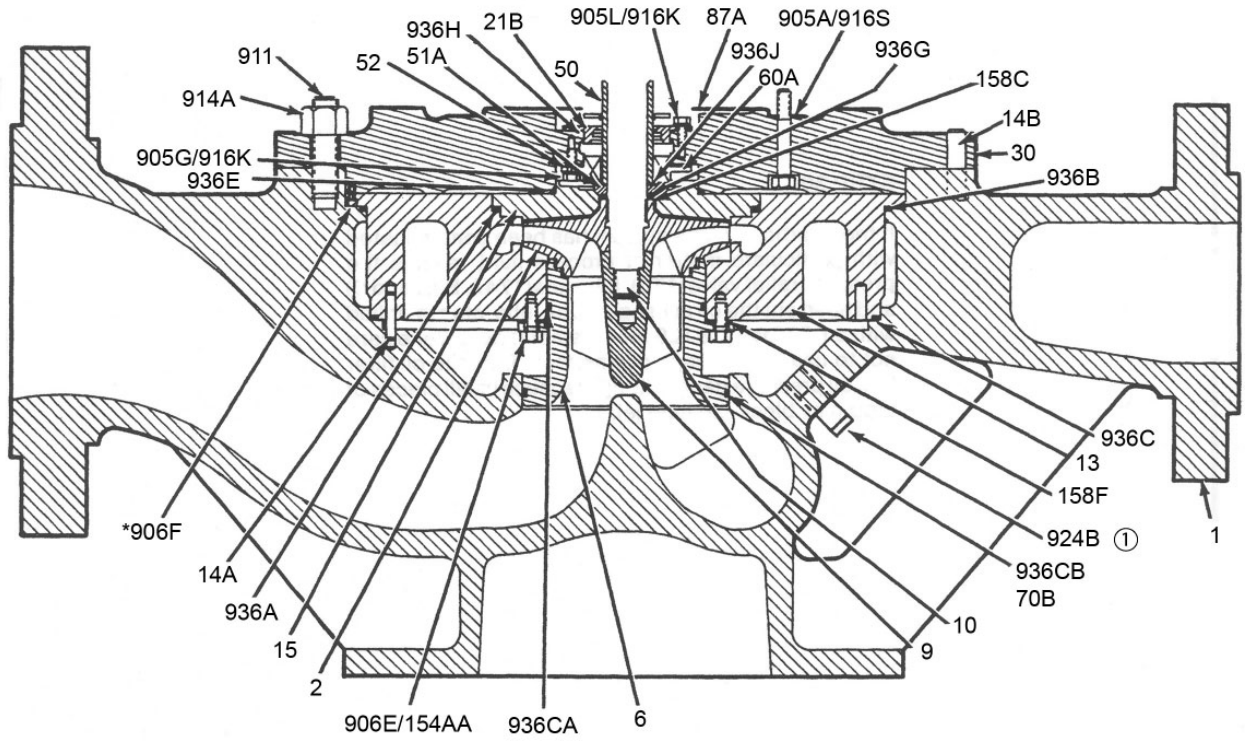
Table 10. Mechanical Seals

	Item No.			Description
	**Lower Process Seal**	**Upper Process Seal**	**Gearbox Seal**	
	60A	60-B	60C	Mechanical Seal Assembly
	61A	61B	61C	Retainer, Seal
	62A*	62B*	62C*	Seal Face Washer
	63A*	63B	N/A	Seal Spring Backup Ring
	64A*	64B*	64C*	Seal Retaining Ring
	65A	65B*	65C*	Seal Spring
	68A*	68B*	N/A	Teflon Wedge
	69A*	69B*	69C*	Secondary may be "U" Cup or O-Ring
	*Seal Repair Kits are Available and contain all parts marked with a single asterisk.			
	Item 60C to be used on gearbox only.			
	To maximize seal performance consult the parts list for correct seal configuration. For additional information, please contact your area representative or the Sundyne factory direct.			

 	1 ½" gas seal for upper tandem position on light hydrocarbon service only
	Gearbox Seal Only

Wet-End Components

Figure 21. Wet-End Components



*Used only with tapered inducer configuration.

① Vent must be open to atmosphere or to safety drain with no back pressure.

Item numbers can be cross-referenced to part numbers using parts list.

Note: *Ensure that diffuser cavity vent (item 924B in the figure above) is open to atmosphere or to safety drain with no back pressure. Failure to do so could result in serious injury or death.*

Table 11. Wet-End Components

Item No.	Part Name	Qty.	Item No.	Part Name	Qty.
1	Pump Housing	1	158C	Impeller Spacer	1
2	Pump Impeller	1	158D	Inducer Housing Shim	AR
6	Inducer Housing, Alignment	1	905A	Screw, Hex Head	4
9	Inducer	1	905G	Screw, Hex Head	3
10	Impeller Stud	1	905L	Screw, Hex Head	3
13	Diffuser Insert	1	906E	Screw, Socket Head	4
14A	Pin, Diffuser Alignment	1	906F*	Screw, Socket Head	1
14B	Pin, Housing Alignment	2	911	Stud, Pump Case	12
15	Diffuser Cover	1	916K	Lock Washer	6
21B	Throttle Bushing	AR	916S	Seal Washer	4
30	Seal Housing	1	924B	Pipe Plug ½" NPT	5
50	Shaft Sleeve Slinger Assy.	1	924D	Pipe Plug ¾" NPT	4
50A	Shaft Sleeve	AR	936A	O-Ring Packing	1
50B	Shaft Sleeve	1	936B	O-Ring Packing	1
51A	Seal Mating Ring	AR	936C	O-Ring Packing	1
51C	Seal Mating Ring	1	936E	O-Ring Packing	1
51D	Seal Mating Ring (Gearbox)(Not Shown)	1	936F	O-Ring Packing	1
52	Seal Spacer	1	936G	O-Ring Packing	2
60A	Seal, Mechanical Lower	1	936H	O-Ring Packing	2
60B	Seal, Mechanical Upper (Not Shown)	1	936J	O-Ring Packing	AR
60C	Seal, Gearbox (Not Shown)	1	936K	O-Ring Packing	2
70B	Backing Ring	1	936P	O-Ring Packing	1
87A	Pump Spacer or Thermal Barrier Gasket	1	936CA	O-Ring Packing	1
154AA	Lock Washer	4	936CB	O-Ring Packing	1

Note: ** Used only with tapered inducer option.*

Gearbox Parts List

Table 12. Gearbox Parts List

Item No.	Part Name	Qty.	Item No.	Part Name	Qty.
51D	Seal Rotating Face	1	158	Shim Spacers	AR
60C	Mechanical Seal	1	160	Lube Pump	1
98	Dust Cover	1	173	Tube (Sump)	1
101A	Gearbox Housing (Output)	1	174A	Lube Jet	1
101B	Gearbox Housing (Input)	1	174B	Lube Jet	1
102	Bearing Plate	1	174C	Lube Jet	1
105	Housing Gasket	2	174D	Lube Jet	1
110	Spline Connector	1	175	Relief Valve	1
115	Shaft Seal	1	180	Filter Manifold (Gearbox Lube Oil)	1
A120	Low Speed Shaft Assembly	1	185	Oil Filter	1
120	- Low Speed Shaft	1	186	Fill and Vent Fitting	1
122A	- Spur Gear (Low Speed)	1	191	Sight Glass	1
123A	- Shaft Spacer (Low Speed)	1	193C	Pressure Gauge	1
125C	- Ball Bearing	1	905H	Hex Head Cap Screw	2
125D	- Ball Bearing	1	905L	Hex Head Cap Screw	3
A130	High Speed Shaft Assembly	1	905M	Hex Head Cap Screw	3
130	- High Speed Shaft	1	905N	Hex Head Cap Screw	3
132B	- Pinion Gear (High Speed)	1	905BU	Hex Head Cap Screw	3
133B	- Thrust Runner	1	909B	Bolt	7
133C	- Thrust Runner	1	909C	Bolt (Alignment)	2
A140	Idler Shaft Assembly	1	914E	Hex Nut	7
140	- Idler Shaft	1	914F	Hex Nut	2
50C	- Journal Sleeve	1	916D	Washer	4
934B	- Retaining Ring	1	916H	Washer	14
122C	- Spur Gear (Idler)	1	916J	Washer (Alignment)	4
123B	- Shaft Spacer (Idler)	1	916K	Washer	3
123C	- Shaft Spacer (Idler)	1	918D	Pin	1
125A	- Ball Bearing	1	920A	Key	1
125B	- Ball Bearing	1	920B	Key	1
151A	Journal Bearing or Tilting Pad, Journal & Thrust Bearing Assembly (Lower)	1	920C	Key	1
151B	Journal Bearing or Tilting Pad, Journal & Thrust Bearing Assembly (Upper)	1	920D	Key	1
154C	Washer	3	924E	Pipe Plug	1
154D	Lock Washer (Lower)	3	924K	Pipe Plug	1
154E	Lock Washer (Upper)	3	936M	O-ring Packing	2
154A	Thrust Bearing Tilt Pad (Lower) (Required with Journal Bearing)	1	936N	O-ring Packing	2
155B	Thrust Bearing Tilt Pad (Upper) (Required with Journal Bearing)	1	936P	O-ring Packing	1
			936T	O-ring Packing	2
			947A	Elbow	1

Figure 22. Gearbox Components

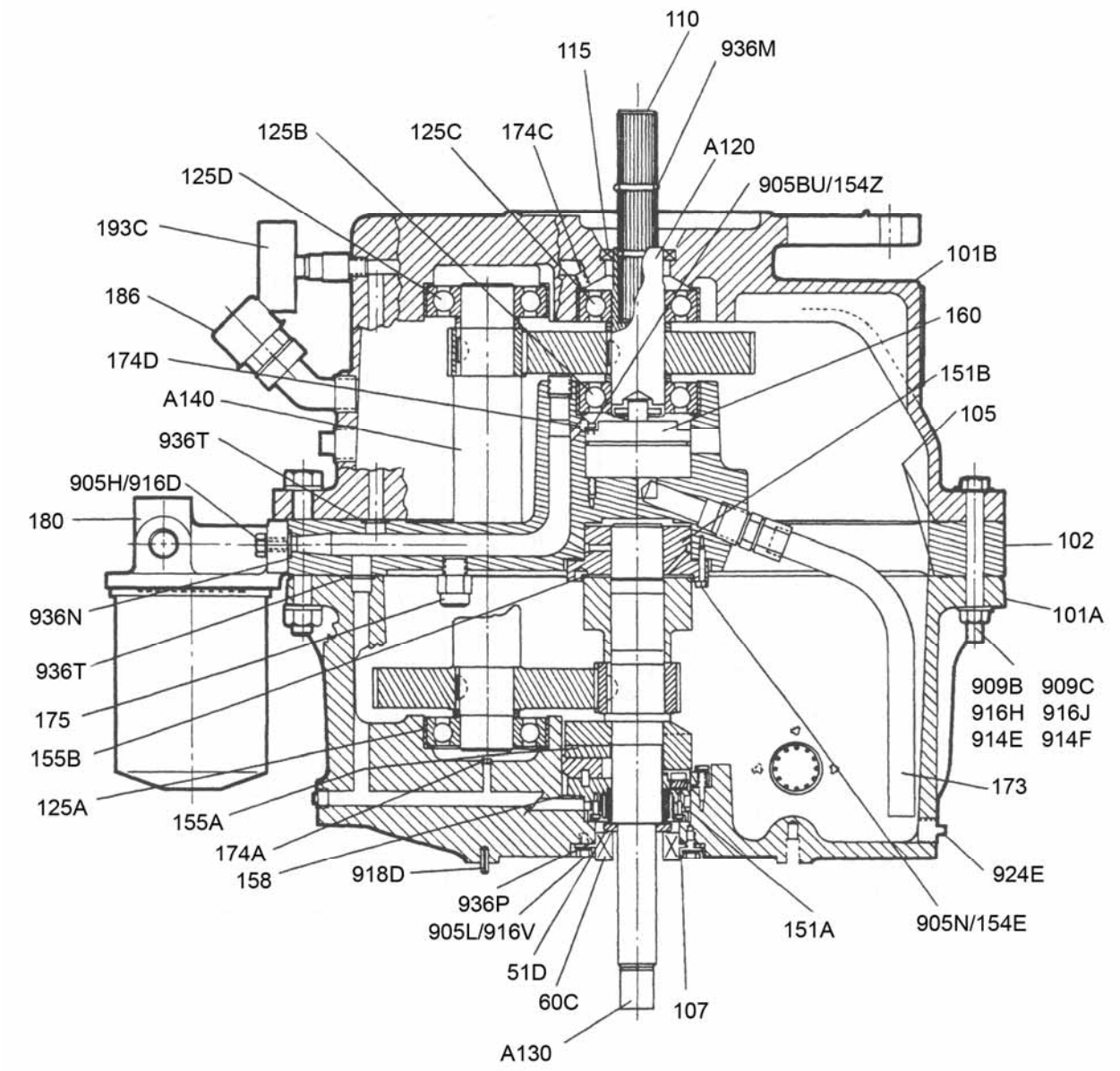


Figure 23. Pump Nomenclature

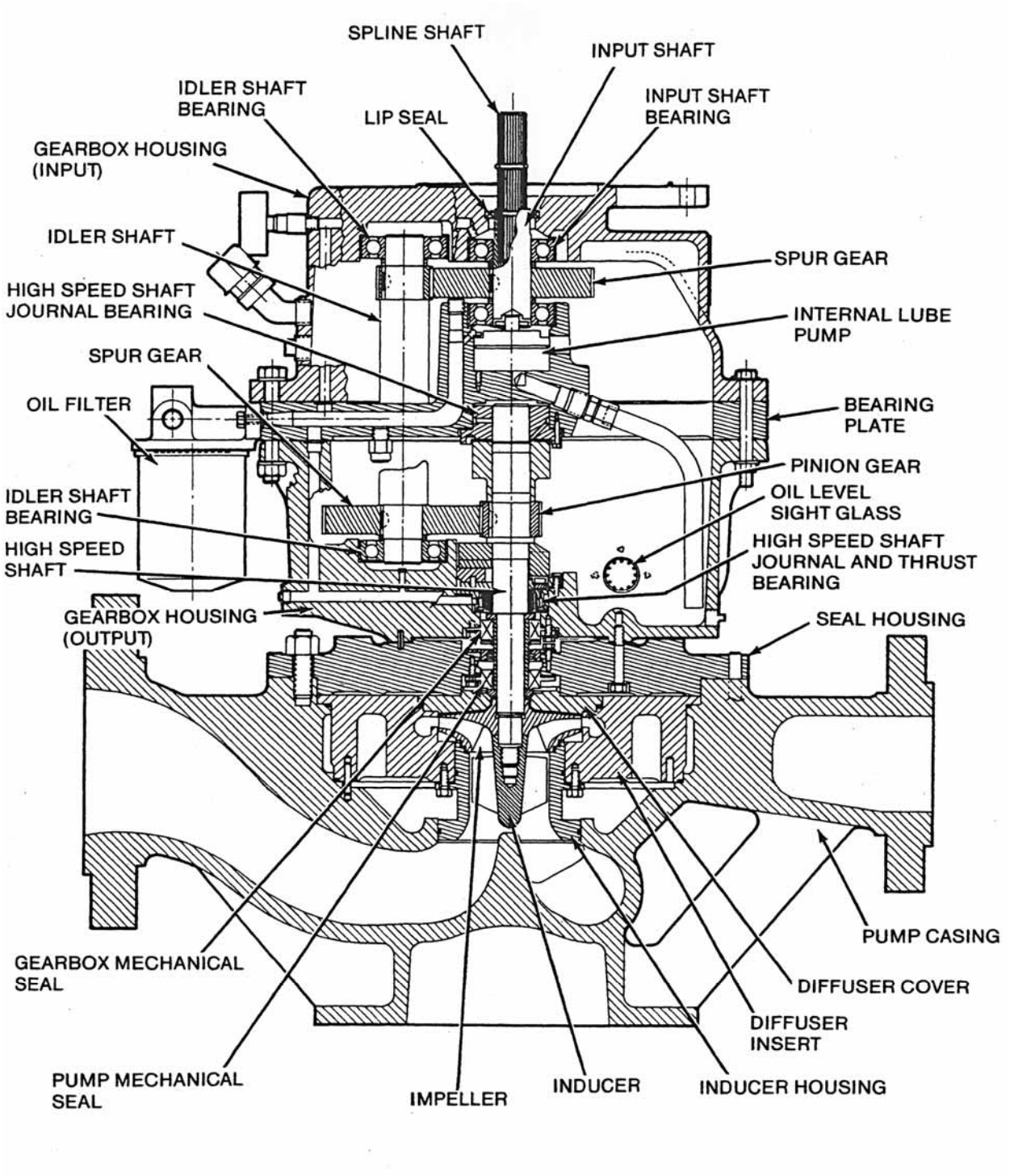
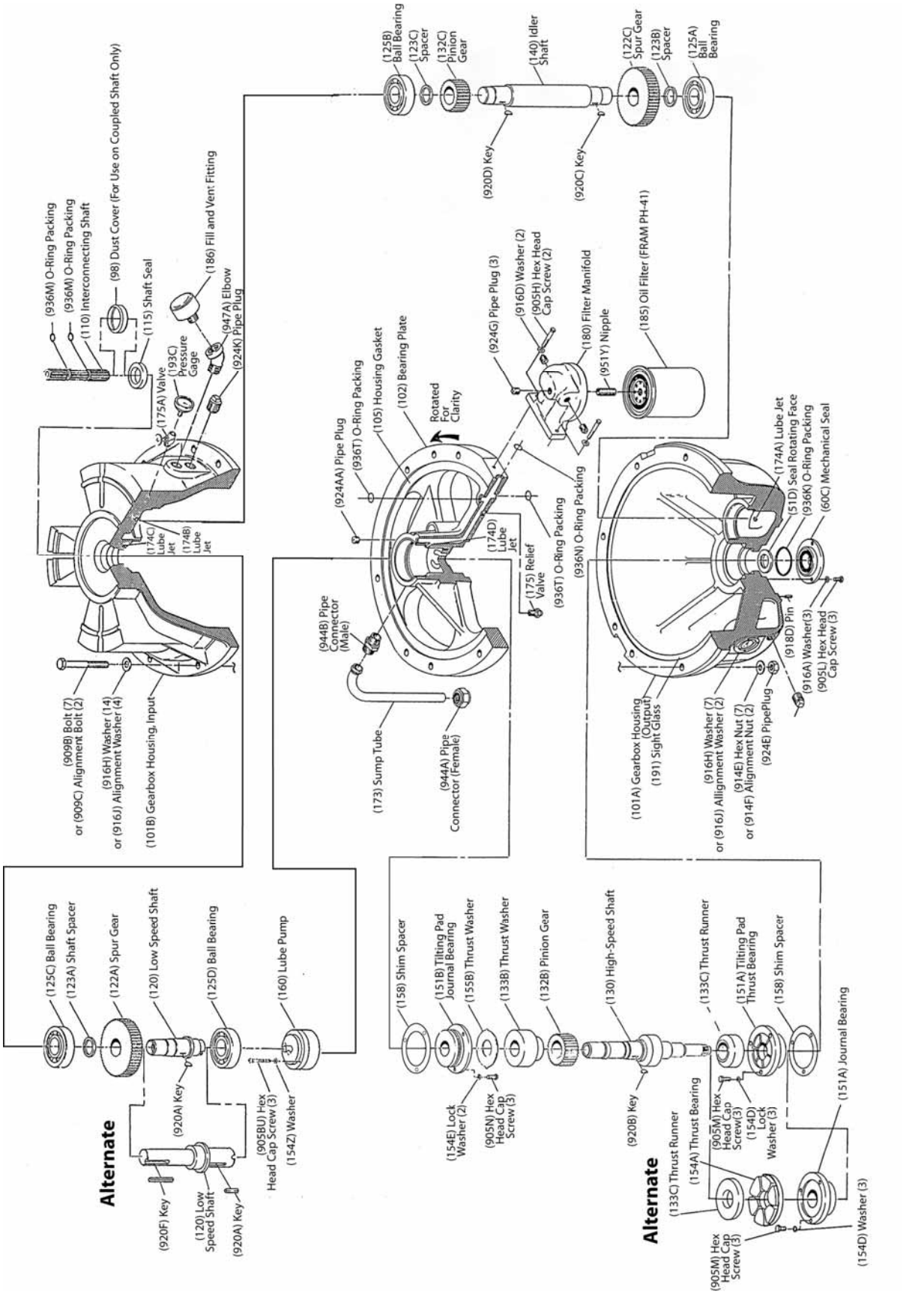
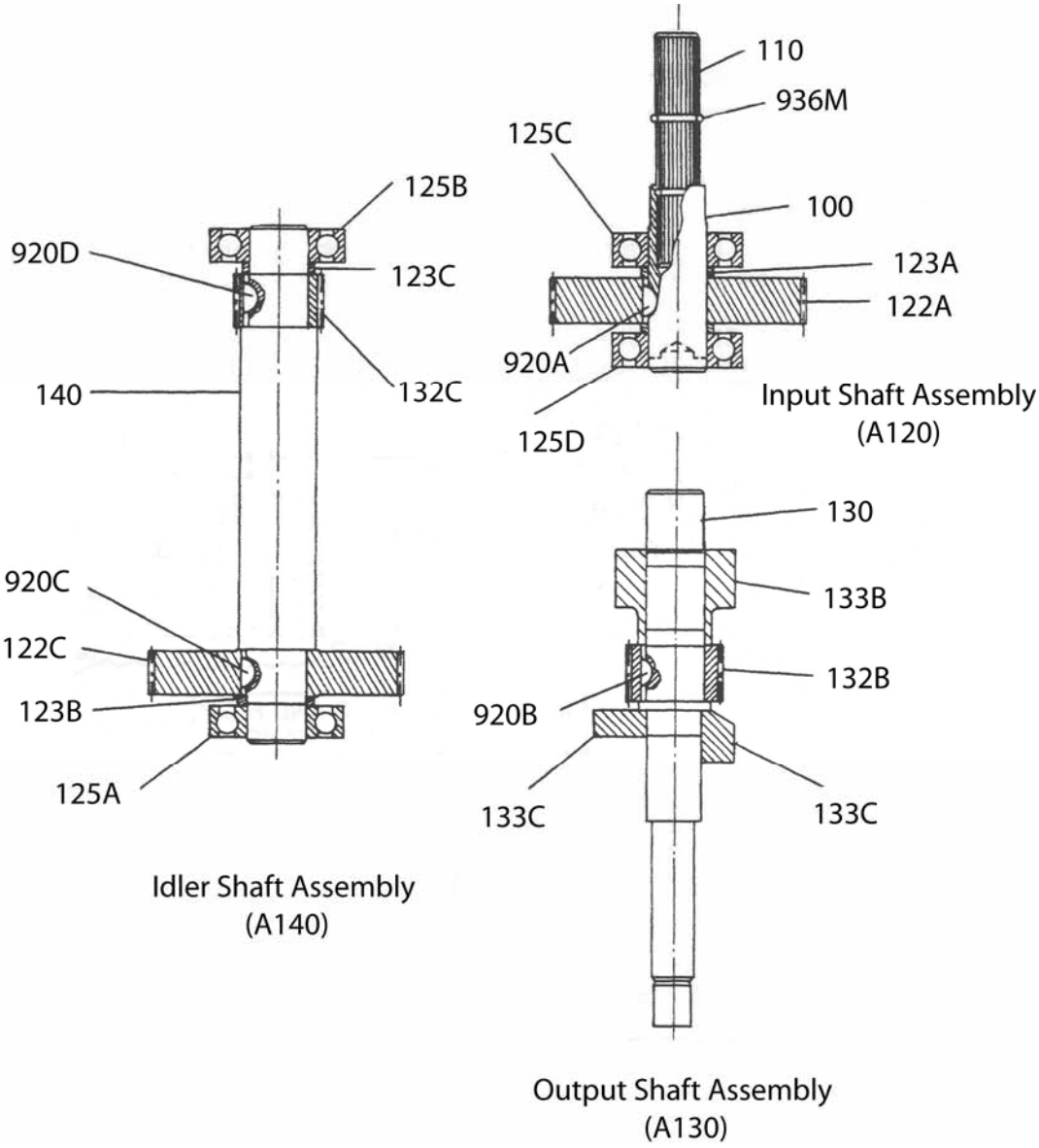


Figure 24. Exploded View



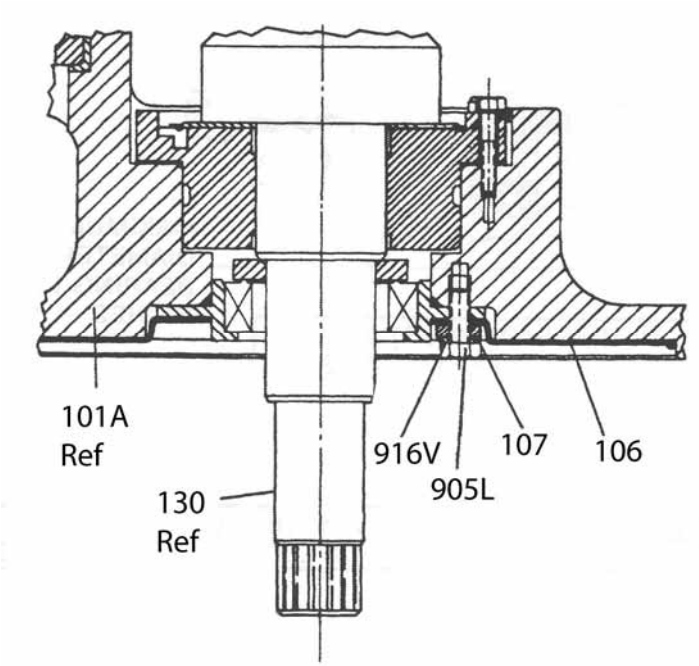
Shaft Assemblies

Figure 25. Shaft Assemblies



Chemical Barrier Gasket

Figure 26. Chemical Barrier Gasket



Item No.	Part Name	Qty.
106	Chemical Barrier Gasket	1
107	Seal Spacer	1
905T	Hex Head Cap Screw	3
916V	Seal Washer	3

Single Seal Arrangement and Parts

Figure 27. Single Seal Arrangement

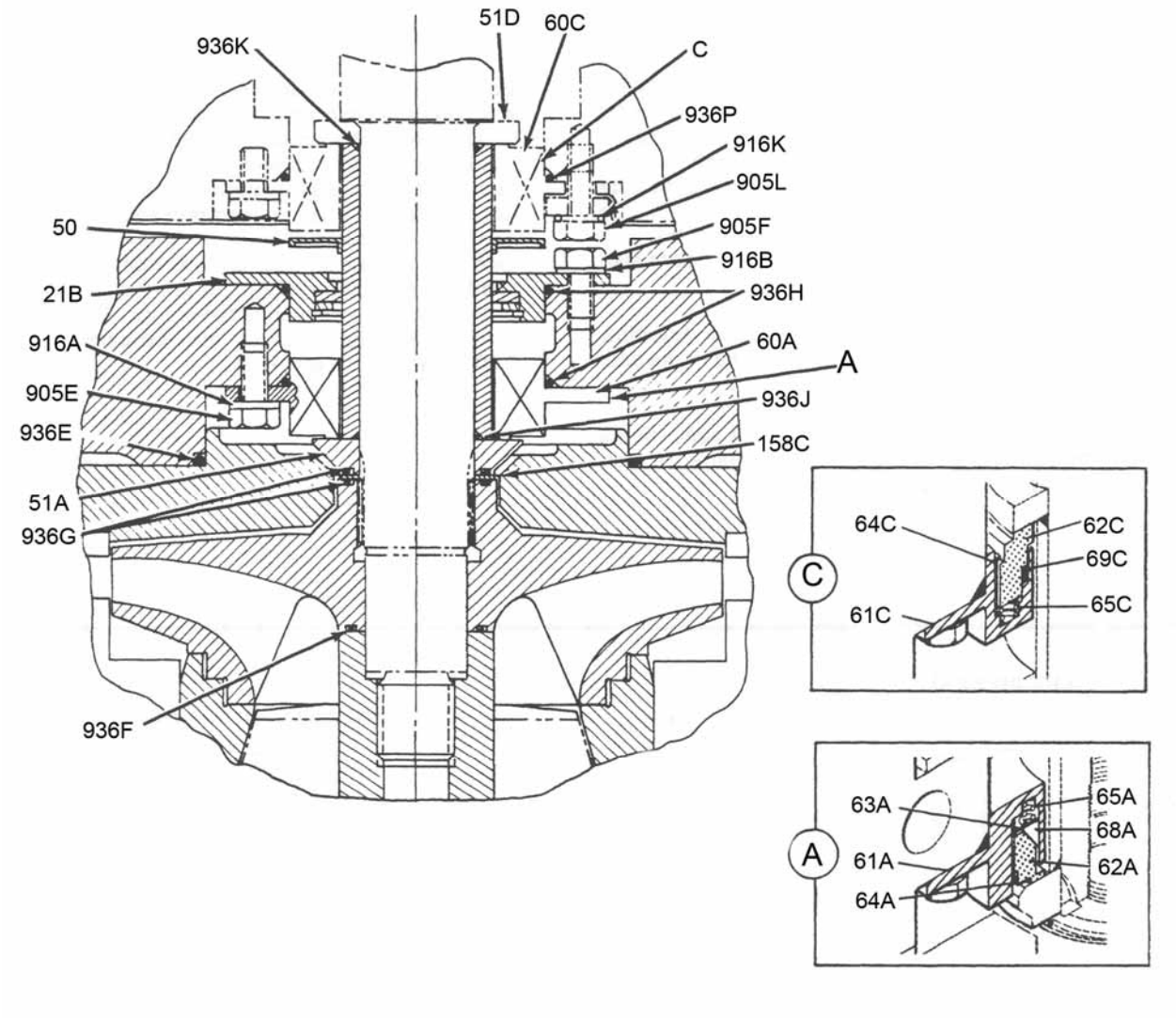


Table 13. Single Seal Arrangement

Item No.	Part Name	Qty.	Item No.	Part Name	Qty.
21B	Throttle Bushing (Upper)	1	62C	- Seal Face Washer	1
50	Slinger Sleeve Assembly	1	64C	- Seal Retaining Ring	1
51A	Seal Rotating Face	1	65C	- Seal Spring	8
51D	Seal Rotating Face (Gearbox)	1	69C	- O-ring Packing	1
52	Seal Spacer (as required)	1	905E	Hex Head Cap Screw	3
60A	Mechanical Seal (Lower)	1	905F	Hex Head Cap Screw	3
61A	- Retainer & Drive Sleeve Assembly	1	905L	Hex Head Cap Screw	3
62A	- Seal Face Washer	1	916A	Washer	3
63A	- Seal Spring Backup Disc	1	916B	Washer	3
64A	- Seal Retaining Ring	1	916K	Washer	3
65A	- Seal Spring	6	936H	O-ring Packing	2
68A	- Seal Wedge Ring	1	936J	O-ring Packing	1
60C	Mechanical Seal (Gearbox)	1	936K	O-ring Packing	1
61C	- Retainer & Drive Sleeve Assembly	1	936P	O-ring Packing	1

Double Seal Arrangement and Parts

Figure 28. Double Seal Arrangement

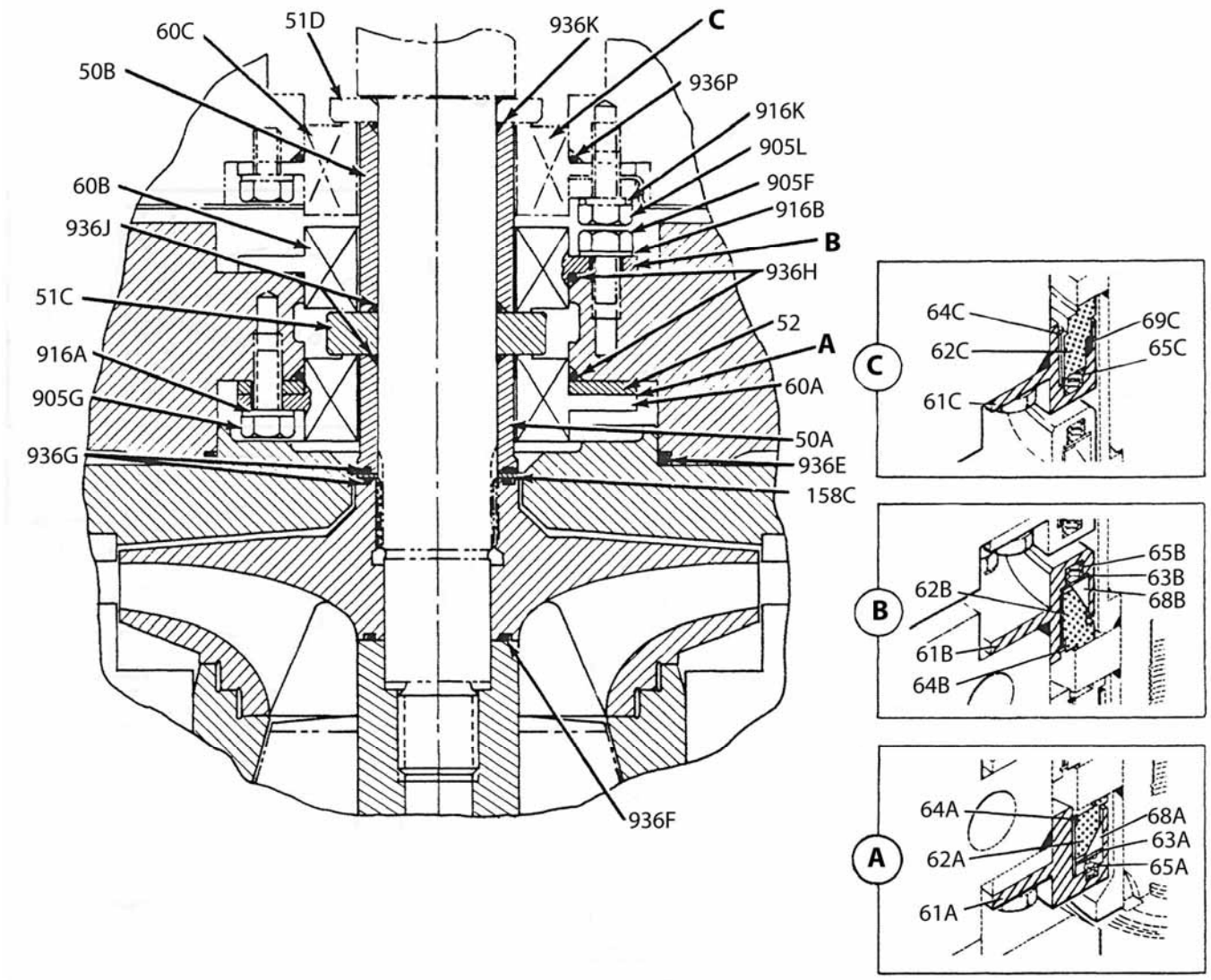


Table 14. Double Seal Arrangement

Item No.	Part Name	Qty.	Item No.	Part Name	Qty.
50A	Shaft Sleeve (Lower)	1	68B	- Seal Wedge Ring	1
50B	Shaft Sleeve (Upper)	1	60C	Mechanical Seal (Gearbox)	1
51C	Seal Rotating Face	1	61C	- Retainer & Drive Sleeve Assembly	1
51D	Seal Rotating Face (Gearbox)	1	62C	- Seal Face Washer	1
52	Seal Spacer	1	64C	- Seal Retaining Ring	1
60A	Mechanical Seal (Lower)	1	65C	- Seal Spring	8
61A	- Retainer & Drive Sleeve Assembly	1	69C	- O-ring Packing	1
62A	- Seal Face Washer	1	905F	Hex Head Cap Screw	3
63A	- Seal Spring Backup Disc	1	905G	Hex Head Cap Screw	3
64A	- Seal Retaining Ring	1	905L	Hex Head Cap Screw	3
65A	- Seal Spring	6	916A	Washer	3
68A	- Seal Wedge Ring	1	916B	Washer	3
60B	Mechanical Seal (Upper)	1	916K	Washer	3
61B	- Retainer & Drive Sleeve Assembly	1	936H	O-ring Packing	2
62B	- Seal Face Washer	1	936J	O-ring Packing	2
63B	- Seal Spring Backup Disc	1	936K	O-ring Packing	1
64B	- Seal Retaining Ring	1	936P	O-ring Packing	1
65B	- Seal Spring	8			

Tandem Seal Arrangement and Parts

Figure 29. Tandem Seal Arrangement

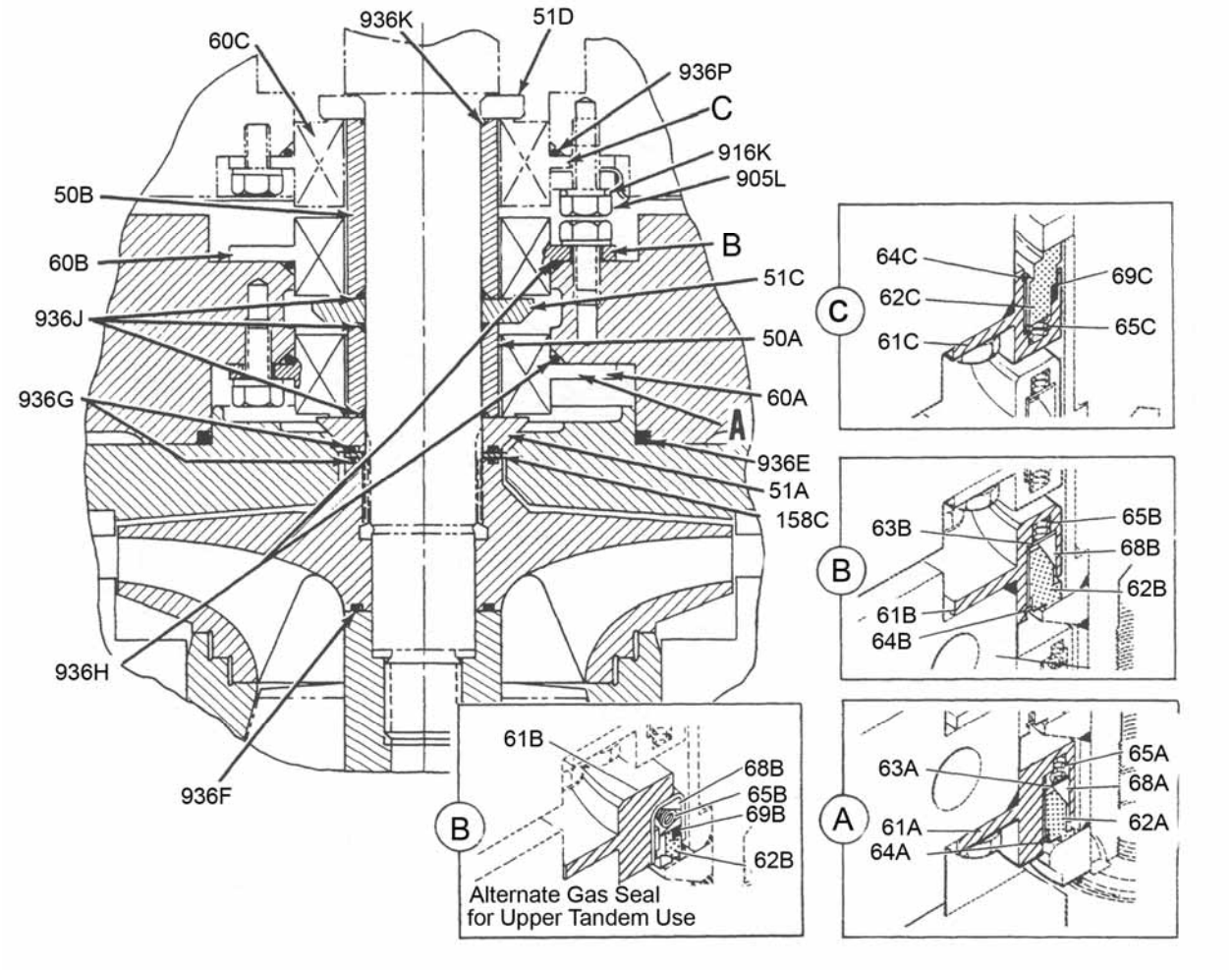


Table 15. Tandem Seal Arrangement

Item No.	Part Name	Qty.	Item No.	Part Name	Qty.
50A	Shaft Sleeve (Lower)	1	62B	- Seal Face Washer	1
50B	Shaft Sleeve (Upper)	1	65B	- Garter Spring	1
51A	Seal Rotating Face	1	68B	- Backing Ring	2
51C	Seal Rotating Face	1	69B	- O-ring Packing	1
51D	Seal Rotating Face (Gearbox)	1	60C	Mechanical Seal (Gearbox)	1
52	Seal Spacer	1	61C	- Retainer & Drive Sleeve Assembly	1
60A	Mechanical Seal (Lower)	1	62C	- Seal Face Washer	1
61A	- Retainer & Drive Sleeve Assembly	1	64C	- Seal Retaining Ring	1
62A	- Seal Face Washer	1	65C	- Seal Spring	8
63A	- Seal Spring Backup Disc	1	69C	- O-ring Packing	1
64A	- Seal Retaining Ring	1	905E	Hex Head Cap Screw	3
65A	- Seal Spring	6	905F	Hex Head Cap Screw	3
68A	- Seal Wedge Ring	1	905L	Hex Head Cap Screw	3
60B	Mechanical Seal (Upper)	1	916A	Washer	3
61B	- Retainer & Drive Sleeve Assembly	1	916B	Washer	3
62B	- Seal Face Washer	1	916K	Washer	3
63B	- Seal Spring Backup Disc	1	936H	O-ring Packing	2
64B	- Seal Retaining Ring	1	936J	O-ring Packing	3
65B	- Seal Spring	8	936K	O-ring Packing	1
60B	Mechanical Seal (Gas Seal)	1	936P	O-ring Packing	1
61B	- Seal Retainer	1			

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